THE

ELECTRICAL REVIEW.

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THE

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THE PORTRUSH FATALITY.

THE opinion of Major Cardew, who conducted the inquiry into this fatality, is:—That Thomas Walne died from the combined effects of severe injury caused by the fall across the rail, and electrical shock; that the tramways in question are at present, when the insulated rail is electrically-charged, a danger to the public and an annoyance to the ordinary traffic; that the Giant's Causeway, Portrush, and Bush Valley Railway and Tramways Company have not paid sufficient attention to the regulations imposed upon them by the Board of Trade.

We need scarcely remind our readers that Mr. Thomas Walne, when riding through the Portrush district last August, attempted to turn his machine on to the tramway; the machine, striking against the curbstone, the rider was upset and fell across the charged rail, where he lay for a few minutes. Although conscious for some time after the accident, he died shortly after he had been removed.

Any one of the findings of Major Cardew would be serious enough, but collectively they form a complete condemnation of the tramway system, and by implication place the responsibility of a man's death on the tramway company. Such a strong opinion will result, no doubt, in the line being closed or altered in such a way that accidents should be quite impossible in future. In speaking of this railway or tramway, we need hardly recall the fact that the track is raised about 5 inches above the level of the road, and that the working conductor is a stiff iron rail placed some 18 inches above the middle of the track. When employing a high voltage current, such a system is primarily a source of danger, and it is most extraordinary that such a line was ever permitted. It may be said on behalf of the company that as the voltage on the working conductor rarely exceeded 250, it could be scarcely considered to constitute a source of danger to the public. No one has any business to assume such a thing. Just as some persons are more predisposed towards disease than others, so there are some more easily affected by electric shock than others. As we said shortly after the accident, Mr. Walne, having ridden through heavy rain, was wet to the skin, and would be easily affected by an electric shock, the fact that he was a heavy man, and lay for a few minutes across the rails, further increases one's belief that he was killed by the electric current. The regulation at the power station was so inefficient, that there is no telling whether the unfortunate Mr. Walne received a shock of 250 or 400 volts. One of the company's officials declared that he had observed readings as high as 360 volts, and if this is not exceeding the danger limit, it is at any rate a clear transgression of the Board of Trade rules. The residents along the line contended that the charged rail constituted a danger to horses and cattle, and an annoyance to the public using the highway. The tramway company have recognised this by indemnifying those who have had animals killed. It is obvious that such

a system, even if it did no more than put animals to a painless death, is out of the question. The company may suffer, but it is of the highest importance that the public should be adequately protected against such a subtle agent as electricity. Major Cardew, in his report, maintains that the company has infringed four very important rules. As regards the electrical working of the line, it has to be borne in mind that the Portrush Railway is a pioneer undertaking, and some indulgence may be granted to the company on this score, though we do not know that even a pioneer undertaking carries with it the privilege of injuring human beings or animals. It may be that it is impossible to bring the line into accord with Board of Trade Regulations; but as these regulations are made mainly for the protection of the public, it is necessary that they should be insisted upon. While the Board of Trade may not have legal powers to immediately close the line, it is to be hoped that the company will act in accordance with their suggestions until they have carried out the alterations decided upon. We do not think the Tramway Company have very much improved their position by issuing, after the inquiry, a sort of manifesto which was ostensibly a statement to the Board of Trade. To seek to make the Board of Trade partly responsible for the mishaps on the line, after unmistakable infractions of regulations, is surely not judicious; but, to claim special consideration on the grounds that they have helped to increase the valuation of the rates of Portrush is rather absurd. We are not altogether out of sympathy with the company. They have to face many difficulties, but there does not seem to be much disposition to accept the position frankly. An increased capital expenditure is at all times a serious matter, but the safety of the public must be maintained, and the maintenance of this safety means the well being of the electrical industry.

The Physiology of Death by the Electric Shock.

We have already referred to the lamentable lack of electrical knowledge displayed by some of the medical correspondents in the *Lancet* in dealing with this interesting question. The letter by Sir George Johnson in last week's *Lancet* is of quite a different order. Sir George Johnson criticises the conclusions of Dr. Bleile, in a masterly manner, and appears to have so completely accounted for the results of the post-mortem examinations as to leave little more to be said on the subject. Sir George entirely disagrees with Dr. Bleile's theory that death is due to stoppage of the heart caused by the contraction of the large arteries. He points out that the large arteries are elastic, but have little or no power of contraction under nervous excitement. This power, however, is possessed in a remarkable degree by the small arterioles leading from the large arteries to the capillaries. These arterioles, in fact, act as the stop-cocks to regulate the flow of the blood. But these arterioles do not contract owing to their nerve centres being directly excited by the electric shock, because in this case the arteries would be congested and not empty as they are always found to be after death by the electric shock. Stoppage of the heart by direct shock is also put out of the question by the fact that one side of the heart is found congested and the other empty. Sir George considers that the condition of the body after death by electric shock corresponds exactly with that found after death by asphyxia. The electric shock paralyses or destroys the nerve centre which controls the respiratory movements; the passage of venous blood into the arterial system causes contraction of the arterioles, and finally stoppage of the heart exactly as in death by drowning or suffocation. There is, therefore, always hope of resuscitation, except when the respiratory nerve centre has been destroyed. Sir George's view agrees with that which was put forward some time ago by Dr. A. D'Arsonval. M. D'Arsonval mentions a case (Electrical Review, Vol. 34, p. 719) in which a workman was stunned by being subjected for a short time to a pressure of 4,500 volts. About a quarter of an hour after the accident, assistance arrived, and artificial respiration was practised. In two hours the man was able to speak, and, finally, was completely restored. The experiments of Dr. Bleile (Electrical Review, Vol. 37, p. 118) appeared to be opposed to this theory that death in cases of electric shock is due directly to asphyxia. In none of the cases, where dogs were killed in his experiments, was he able to restore animation by artificial respiration, but Sir George Johnson points out that the shocks were large enough to destroy the respiratory nerve centres and place recovery out of the question. The effect of nitrite of amyl which Dr. Bleile relied so much upon as supporting his view, is known to be similar in cases of asphyxia. The administration of this drug in cases of asphyxia has been found to prolong the action of the heart for a considerable time after it had almost ceased to beat. Its action is to relax the pulmonary arterioles and allow the blood to pass from the right to the left side of the heart. The conclusions of Sir George Johnson on this subject appear to us to be authoritative, and, as we have shown time after time, it may often be the means of saving life to remember the dictum, that "a man struck by electricity should be treated as if drowned."

Station Capacity.

Some statistics published by Dr. Fleming in his report to the Corporation of Plymouth on their proposal to establish a municipal supply of electricity in that borough, raise the question as to the manner in which comparisons may be fairly instituted between different stations already at work. Dr. Fleming appears to base his calculations on the cost per kilowatt installed in each case. This is just only in so far as the examples cited are of approximately equal total capacity; a small station will inevitably show a larger unit cost in this way than a larger one which has been longer at work. This arises from the fact that mains are items that are generally put in with some view to after developments, and are therefore excessive compared to plant erected, while buildings are in a similar manner provided for expected extensions in the near future. Still, if comparisons must be made, this is a better and more equable procedure than to compare cost of station and mains per lamp wired. Here the district factor comes in; a residential supply may wire up more heavily than one that deals with a shop and office quarter, and as local conditions can seldom be ascertained and allowed for, the best way is never to make such misleading commentaries. Last of all, we fail altogether to appreciate the utility of such data as "Capital cost per Board of Trade unit sold," for this may be anything or everything. Neither of the last two factors—lamps wired per kilowatt of plant, or units sold per annum—can be appreciably controlled by those who design stations, but the other is in their hands.

Lamp Averages.

In another column we give the averaged results of some tests recently made upon lamps of English manufacture. One important fact can be deduced from these results, and it is worth while to call attention to it. The term "lamp" is, now-a-days, generally held to mean one of 8 C.P., and it is the custom to express central station loads in terms of the equivalent number of such lamps on their circuits. For this purpose a "lamp" means a power of 35 watts. From the mean of the averages of the English lamps tested, it appears that 38 watts per 8 C.P. lamp is about the proper figure, so that the statistical "lamp" is, if anything, more economical and not less so than its practical variety. On this basis 28 lamps are equal to one kilowatt, and for approximate calculations the indicated horse-power of the engines in a central station may be taken as twice the maximum total kilowatt output. The general results of the lamp tests cited show that a 16 C.P. lamp consumes power at the rate of 60 watts, and gives an average of 14·21 C.P. at an expenditure of 4·27 watts per C.P., while the 8 C.P. requires 38 watts and gives an average of 7·81 C.P. at an expenditure of 4·9 watts per C.P. These efficiencies are considerably below the figures usually given, but there are no good grounds for doubting their correctness.

AN ELECTRO-MAGNETIC RAILWAY SYSTEM.

After accumulators, we suppose no method of electric traction has called forth more ingenuity than conduit systems. Although one is constantly reminded, generally by those who ought to know better, that an open conduit can be made to work successfully, as exemplified by the one at Buda Pestb, there is, to our mind, very little doubt that a slot in the middle of a street is an unmitigated nuisance. Who amongst us has been free from the occasional embarrassment, not to say humiliation, caused by the end of one's stick or umbrella fixing firmly in a hole in a grating without our immediate knowledge. We know of nothing that compares with the jerk that follows. A similar experience once befel us as we crossed over an electric conduit, and strenuous efforts were needed to extricate one's stick in time to allow an approaching tram to pass with safety. A closed conduit immediately surmounts many of the difficulties incidental to an open one. Those that have worked on the question have recognised that safety to the public is the first desideratum; most efforts have therefore been directed to making the system non-conducting, save when the car was passing. Such a method generally necessitated some magnetic arrangement. One of the cleverest of these was the one suggested and used by Mr. Lineff; but in spite of its ingenuity, it met with no success. It may be remembered that in this system a flat discontinuous strip of metal was placed in the centre of the track. The cars being provided with huge magnets, weighing three-quarters of a ton, made each strip alive, simply by attracting to the under side of the strip a second strip connected to the supply mains. As the car left each strip the magnetic arrangement fell by gravitation, thus disconnecting it from the circuit. There were many objections to this system; it was very necessary that the centre strip should be kept clean, and the huge magnets on the cars were not very desirable.

View of Two-Stud Track.

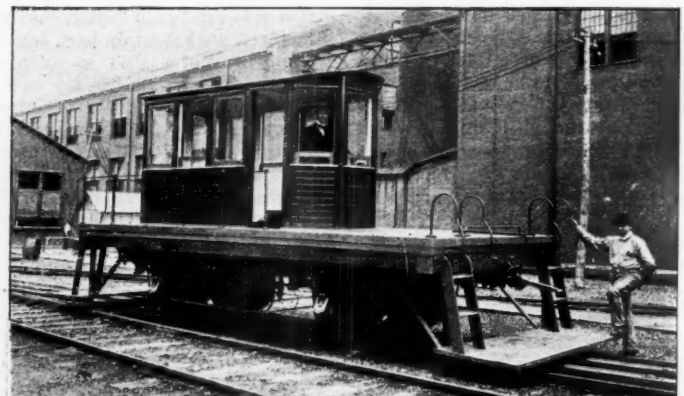
We have recently had the privilege of examining a system introduced into this country by the Westinghouse Company, which is more in accordance with practical conditions than any we have seen before. As in the Lineff system, the main feature is an electro-magnetic arrangement, but instead of being done from the car, all the electro-magnetic mechanism is arranged underground. It will be seen from the following description how very simple the system is. Before proceeding with it, however, we should just like to mention that the Diatto electric conduit, described in another part of this journal, seems to be a combination of the Lineff and the Westinghouse systems. It is similar to the Lineff in that it carries the electro-magnet on the car, but it approximates to the Westinghouse in carrying a collecting bar, which collects current from metal studs.

The Westinghouse electro-magnetic system cannot be very well called a closed conduit one, though as such it is generally spoken of. It possesses, however, most of the merits of a closed conduit system, with a distinct lessening of its failings.

Perhaps the simplest way of explaining the system is to draw attention to the peculiar construction of track. An external examination reveals nothing but three metal studs, slightly raised above the surface of the road; so slightly, however, that it is unlikely that they will interfere with horse traffic. Near these studs, but outside the track, is an iron box which contains the magnetic switching gear. These studs and boxes are placed about 13 feet apart, the distance varying with the length of the car. The studs are connected underground to the box by means of three separate wires. Before proceeding to consider the matter in detail, it should be explained that these boxes are connected together by wires. which are fed by the feeders from the power house. The operation of the system will be at once seen when we describe the construction of the car. As regards working parts, it does not materially differ from the ordinary trolley car, save that it is minus the trolley. Suspended underneath the car, however, are three iron bars, which are so arranged that each one will rub a stud as it passes along. We will call one the magnetising bar, the second the collecting bar, and the third the return bar. The magnetising bar is connected to a small storage battery carried on the car. When the car passes over the studs a low pressure current is discharged from this bar down the metal stud into the box. Here the current energises the shunt winding of an electro-magnet, which immediately attracts its armature. As this armature is directly connected to the cables carrying 500-volt current, this immediately passes through the series winding of the magnet, and reappears at the second stud in the roadway, its course then being through the collecting bar to the motors on the car. The return is effected through the third bar and the third stud into the box, and from thence into the return main. In connection with the armature is a bridge piece, upon which are carbon faces; when the magnet acts, these carbon faces are brought into close contact with others on the insulated portion of the magnet. Naturally one set of carbon faces is directly connected to the 500-volt circuit, and the other set to the cable leading to the stud. The operation, therefore, of bringing the current to the car motors is an exceedingly simple one. The means taken to protect the electro-magnetic mechanism, both mechanically and electrically, are very complete. The box containing it occupies very little space in the ground, and, we understand, calls for little inspection. The collecting bars on the cars are of such a length that one end has not left one set of studs before the opposite end has made adequate contact with the next set. It is obvious that the distance apart of the studs and boxes varies with the length of the car, the longer the car the wider apart are the studs and the cheaper is the construction.

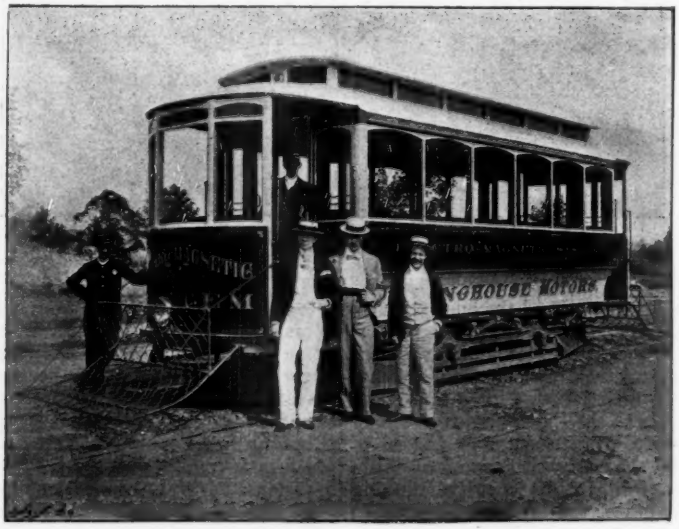
We think it has been made clear by the foregoing remarks that it is practically impossible for a person to receive a shock. If there is the slightest chance of shocks being received, the ordinary boy will find it out, but to achieve success it will be necessary for him to connect a set of batteries to one stud; he will then require to place his feet on the other two studs, and if fortune favours him he may contrive to receive the effects of 500 volts. Each set of studs as they are left by the car are completely disconnected from the live mains. There is absolutely no difficulty in the way of the cars picking up the current quickly; we understand that in America 20 miles an hour has been attained without the slightest trouble. The

magnetic boxes can be easily disconnected from the track if necessary; in such an event the momentum of the car would carry it on to the next set of studs. It ought to be explained that the use of rails as a return dispenses with one of the studs and one of the bars under the cars. When the line is a double one the cost of construction is very much reduced, because one magnetic box will contain the apparatus necessary for both lines. The studs are usually fitted into earthenware casings, which are strong enough to withstand the pressure of a steam roller. The size of the studs is about 4 inches in diameter. It will be seen from the illustrations that there is very little interference with the road surface, the studs not being more than $\frac{3}{8}$ths of an inch above the road.



Electric Locomotive in Westinghouse Yard, Capable of Drawing 250 Tons.

This system has been used in America for the past 18 months. In the yards of the Westinghouse Company several miles of rails have been fitted with the system, freight cars equipped with motors being used in place of steam locomotives. Besides this, the system has been used for many months upon a tramway system outside Washington. It appears in this case to have worked with some success. We understand that the leakage is very small, which, considering the excellent insulating methods employed, is not surprising. It seems to us that winter weather might cause some little trouble; it would be necessary to keep the studs clear of ice and snow; but with the experience that has been gained in operating the system, these troubles are no doubt easily surmounted. It is admitted that the system is more expensive to construct than an overhead wire system; but it should be certainly less expensive than most conduit systems. It possesses, however, one distinctly good feature, and that is the possibility of combination with an overhead wire system.



Electro-magnetic Railway.—View of Car.

The cars, so far as electrical equipment is concerned are precisely similar to trolley cars; indeed, a car fitted with trolley pole and parallel bars underneath would be able to make a journey over a line which was partly equipped with overhead wire and partly with the electro-magnetic system. Where there was a great objection to putting up overhead wires in a town, it might be possible to employ this plan inside the town and the trolley outside. At the same time the prejudice to the trolley is fast dis-appearing, and the electro-magnetic system will have to enter into competition with it.

Obituary.—We learn with regret of the death, which occurred on 25th ult., of Julius Maier, Ph.D., whose name will be known to many of our readers. Mr. Maier was 55 years of age at the time of his decease.

ELECTRO-METALLURGY AS APPLIED TO SILVER REFINING AND INCIDENTALLY TO OTHER METALS.*

By GEORGE FAUNCE, B.A.S., Superintendent Pennsylvania Lead Company.

(*Continued from page* 523.)

Principles.—Before entering upon a description of these processes, it will be well to give a very concise *résumé* of the principles underlying electro-chemical action.

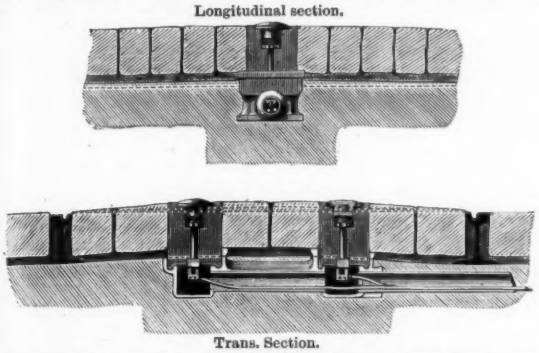
1. Whenever electricity is generated, whether by friction, by galvanic action, or by motion in a magnetic field, there is set up a tendency for the electricity to flow from one place to another; *e.g.*, from the positive to the negative pole. This tendency is strong or weak, according to the nature of the generating cause, and is measured by the capability of the current to overcome the various resistances opposed to its flow. This capability of overcoming resistance is called the electromotive force. It is analogous to the pressure of steam, or to the force of a head of water. A certain E.M.F. will transmit a given quantity of electricity through a given resistance in a second. If the resistance be increased, the same E.M.F. will transmit a certain smaller quantity in a second, and *vice versâ*.

The quantity of electricity which passes through a given circuit in a given time is a measure of the intensity of the current. The power of decomposing chemical compounds is proportional to the intensity of the current. Although it is true that a definite minimum E.M.F. is necessary before any decomposition will take place, when this limit is once reached, the quantity of material decomposed in a second will depend entirely on the intensity of the current, and not at all on the E.M.F., which may be increased to any extent without changing the rate of deposition.

The electrical resistance of a conductor of electricity is the property it possesses of impeding the flow of a current through it; that is, of diminishing the quantity of electricity that will pass through it in a given time, when urged by a given E.M.F. The resistance of a conductor is inversely proportional to its section and directly proportional to its length and to its temperature, except that with liquid conductors the resistance decreases with increased temperature. Compared with the metals, liquids have an enormous resistance. The best conductors among liquids have a resistance many thousand times greater than that of the most

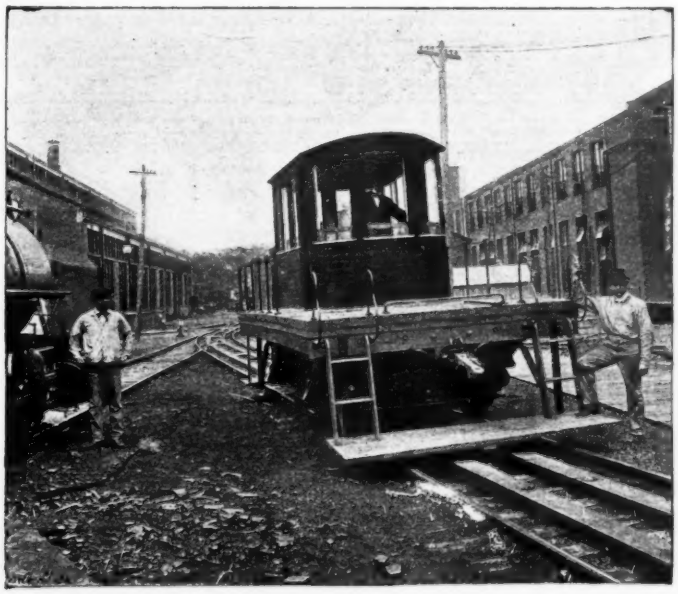
* A lecture delivered before the Franklin Institute.

resisting metal. The relative resistance of liquids is decreased by the presence of acids or metallic salts. The practical unit of E.M.F. is the volt, and is very nearly equal to the E.M.F. of the current generated by one Daniell cell.



Electro-Magnetic Railway System.—Sections of Collecting Studs (page 531).

The unit of intensity is the ampère, and is taken to be that current which will deposit in one second of time 1·12 milligrammes of silver. The unit of resistance is the ohm, and is represented by a column of mercury about 3½ feet long and $\frac{1}{25}$th inch square, at 32° F. A current having an E.M.F. of 1 volt, will transmit a current of 1 ampère through a resistance of 1 ohm in one second. Please keep in mind the meanings of these terms—volt, ampère, and ohm—and note that the depositing power of a current depends not on the E.M.F., or voltage, of a current, but entirely on its intensity, as shown by the ampèremeter. I emphasise this, because I have sometimes found it difficult to convince so-called electrical experts that a high voltage would not answer just as well for depositing purposes as the required number of ampères.



Electro-Magnetic Railway System.—Electric Locomotive in Westinghouse Yard (page 531).

2. The relation existing between these three factors in any current produced by a given constant cause is embodied in what is known as Ohm's law, which is as follows :—

The intensity of the current, C, is obtained by dividing the E.M.F., E, by the resistance, R, thus :

$$C = \frac{E}{R};$$

whence

$$R = \frac{E}{C},$$

and

$$E = C\,R.$$

By the aid of these formulæ, if any two of these factors are known, the third is easily found. Thus, if the ammeter shows the current through a given circuit to be 100 ampères, while the voltmeter shows an E.M.F. of 50 volts, it is evident at once that the resistance of the circuit is

$$R = \frac{E}{C} = \frac{50}{100} = \tfrac{1}{2} \text{ ohm.}$$

3. It is essential, in preparing for any industrial process, to know the amount of work that is to be performed. We find that the amount of work done by an electric current is equal, in kilogrammetres, to the product of the ampères by the volts, divided by g, the gravitational acceleration (= 9·81), or

$$W = \frac{C\,E}{9{\cdot}81}.$$

For example, if a machine generates a current whose E.M.F. is 100 volts, and whose intensity is 200 ampères, it will perform work as follows :

$$W = \frac{100 \times 200}{9{\cdot}81} = 2{,}040 \text{ kilogrammetres};$$

or, as 75 kilogrammetres = 1 horse-power, the work performed will be 27·2 horse-power.

4. When a current of electricity passes through certain liquids, it will decompose them. This operation has been termed by Faraday, electrolysis. The liquid in which the decomposition occurs is called the electrolyte. The electrodes are the conductors immersed in the liquid, the anode being the electrode through which the current enters, and the cathode the one through which it leaves the bath. In order to produce electrolysis, the substance to be decomposed must be a conductor of electricity, and it must be a liquid ; *i.e.*, either in solution or in a state of fusion. When decomposition takes place, the hydrogen, metals, or bases flow to the cathodes, while the oxygen, or acids, flow to the anodes. If the anodes are soluble, or attackable by the products of electrolysis, they will be gradually dissolved or oxidised. The accumulation about the anodes of the products of decomposition, and of the oxides formed from the metals of the anodes, interferes considerably with the efficiency of the current, on account of the resulting polarisation, and the tendency to set up currents in a direction opposite to the decomposing current. These effects can be partially prevented by constant agitation of the bath.

5. Faraday, in 1834, gave us two important laws governing electrolysis :—

(*a*) The quantity of substance decomposed in a given time is proportional to the intensity of the current (or the quantity of electricity passing through it). A corollary of this law is that, in order to set free a given quantity of any substance, a constant quantity of electricity is required. These two quantities are electro-chemical equivalents.

(*b*) The same current acting at the same time on a series of solutions of various kinds will separate in each solution definite weights of the constituents in the ratio of their chemical equivalents. If, for instance, the current traverses tanks containing, respectively, water, lead acetate, and silver nitrate, for each gramme of hydrogen set free in the first tank there will be found, respectively, 103·5 grammes of lead, and 108 grammes of silver in the others.

Various causes operate to interfere with the action of these laws, notably, the secondary currents engendered at the anodes by oxidation, &c.

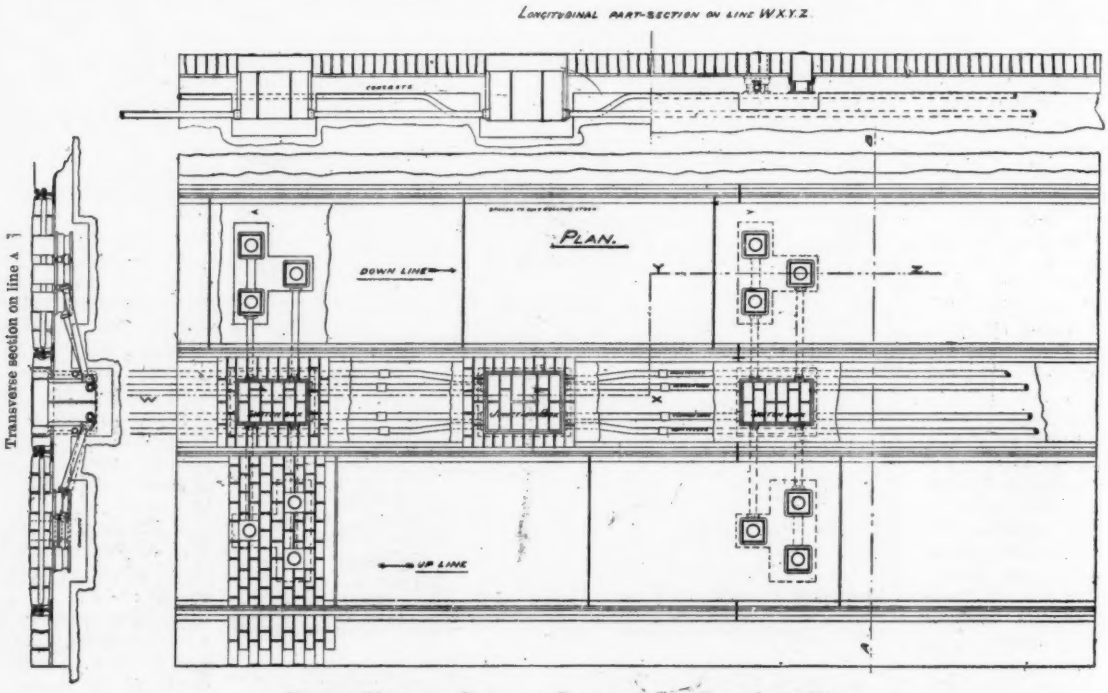
6. The work absorbed in decomposing a given substance is equal to the work corresponding to the heat produced by the recombination of the elements or ions of the decomposed substance to form the original compound. As 1 ampère will decompose constant amounts of an electrolyte with varying E.M.F., it follows that to electrolyse a given compound, it will be necessary to use certain minimum E.M.F. Whatever be the quantity of electricity that passes through the

electrolyte, no decomposition will take place until this E.M.F. is reached. Thus, for example, to decompose water, an E.M.F. is required of nearly $1\frac{1}{2}$ volts; for chloride of zinc, $2\frac{1}{2}$ volts; for copper sulphate $1\frac{1}{4}$ volts; for copper nitrate $1\frac{1}{4}$ volts; for lead nitrate $1\frac{1}{2}$ volts; for silver nitrate only $\frac{3}{8}$ths volt, &c.

7. When several metals are in the same solution, that one will be deposited first which, under existing conditions, is most electro-negative.

The purity of the deposited metal depends on various other conditions, viz., the acidity of the solution, and the amount of other metals present in solution. These other more electro-positive metals are more likely to be deposited in a neutral or alkaline, than in an acid solution, and if they are present in too large quantities, they will be thrown down with the negative metal. In a solution containing silver, copper and lead nitrates, the current will not deposit a trace of anything but silver, if the proper amount of acid is present, unless the lead and copper get to be considerably in excess of the silver. There is no danger of the deposition of copper, even when the solution contains $1\frac{1}{2}$ times as much copper as silver.

8. When the anodes are soluble, and of the same kind as the deposited metal, as is generally the case in refining by



Electro-Magnetic Railway.—Double Track Road (page 531).

electricity, the work absorbed by the decomposition is exactly replaced by the energy produced by the solution of the anode, and the consequent regeneration of the electrolyte. But this does not mean that no work is required in these electrolytic processes. On the contrary, a large amount of work is absorbed in overcoming the resistance of the circuit, in making up for leakage of electricity, in counteracting polarisation and reversal of the currents, in working pumps, stirrers, &c., so that the sum total of work performed, and consequently of power consumed, in these plants is very considerable.

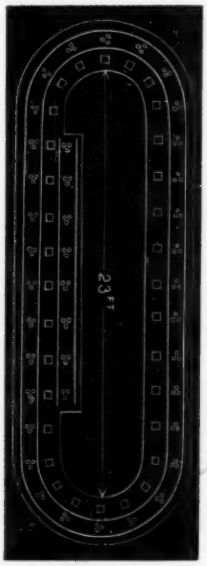
With this very brief review of the facts and laws which directly affect electrolysis, you are prepared to follow me in a description of that process with which I am most familiar, and to take a glance at some of the other allied processes which have lately come into great prominence.

Moebius Process.—The process now in use for the electrolytic separation of silver and gold was patented by Bernard Moebius about 10 years ago. He installed his first plant in Mexico, where he perfected his process, and proved its feasibility. He next introduced the process into the Kansas City Refinery; but for some unexplained reason it was very soon abandoned. The next to take hold of the new process was the Pennsylvania Lead Company, which, on the advice of its efficient superintendent, the late F. C. Blake, secured the sole right for the State of Pennsylvania, and erected a complete plant in 1886. The original plant consisted of 49 baths, guaranteed to refine 10,000 ounces of silver per day. Shortly after the completion of the original plant, the capacity of the establishment was doubled, by the addition of 49 more baths, making the total guaranteed output 20,000 ounces of silver per day. The process was successful from the beginning, and has worked smoothly and continuously, without a day's interruption, up to the present time. It has been so managed as to turn out twice as much as the guaranteed output, or 40,000 ounces per day, and this with only 84 baths, which is the largest number that can be run continuously.

A small plant was in successful operation for a short time in New York City, but was abandoned, I think, for commercial reasons. Mr. Moebius has recently installed another plant at Pinos Altos, in Mexico, and has only just completed one at St. Louis. Thus, until very recently, the plant at the Pennsylvania Lead Works, at Pittsburgh, has been the only one in the United States in continued successful operation. And here a few words in explanation of the relative position of this process in the general work of the establishment.

The primary object of the company was the production of refined lead suitable for corroding into white lead. Practically all the lead bullion now produced west of the Mississippi Valley carries more or less silver and gold. In refining the lead bullion, these impurities (for so they are to be considered) must be eliminated. Therefore, treatment of gold and silver becomes an essential part of the business of refining lead. The silver and gold are taken out of the lead by means of zinc, which, when intimately mixed with the lead, takes hold of the precious metals and bears them to the top of the bath. The resulting zinc-silver-lead alloy is skimmed off and subjected to a high heat, by which the zinc is distilled off and recovered by condensation, while the alloy of lead, silver and gold, left from the distillation, is cupelled. By the process of cupellation the lead is oxidised, being converted into litharge, which runs off the metal, leaving finally the alloy of silver and gold in the cupel. This silver-gold alloy (called doré bullion), it was formerly customary to ship to the New York Assay Office, where it was parted at a cost of 1 cent. per ounce. Now it is taken to our own parting-room, which is merely an addition to the regular operations of the company. Although the process is of the nature of a side issue, it has enabled the company

to undertake an immense business in the way of refining silver bars from amalgamating mills, and silver sulphides



Electro-Magnetic Railway.—Plan of Model Track (page 531).

from lixiviation works, which could not have been handled economically without the aid of this, or some other parting process.

(To be continued.)

THE DIATTO UNDERGROUND CONDUIT SYSTEM.

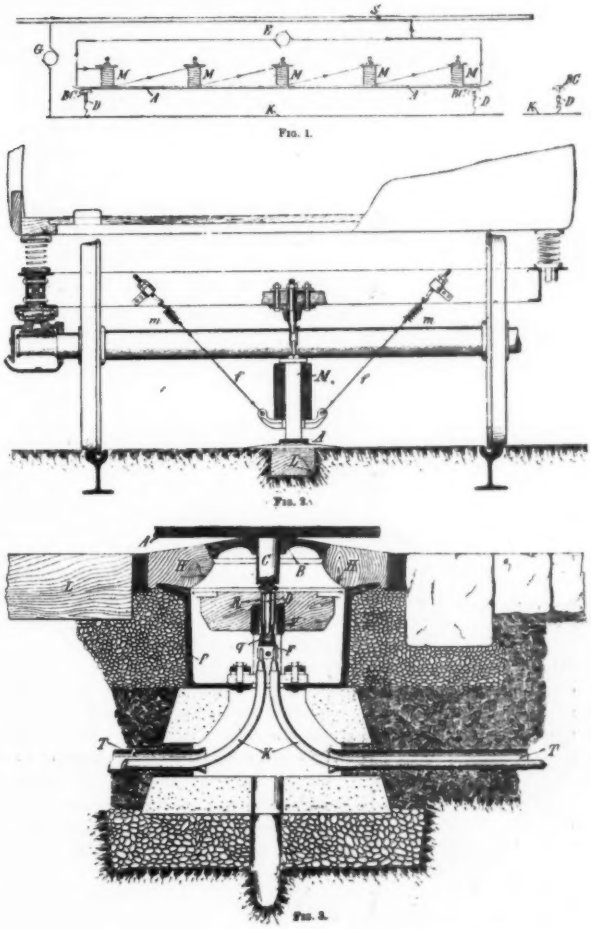
About a year ago a short length of electric tramway on the Diatto system was laid down in Turin for the purpose of demonstrating the practicability of the system. This experimental line, which was worked during the snow of last winter, has been operated since that time with success, the speed of the cars being at the rate of 10 miles an hour. A description of the system is given in the *Elektrotechnische Zeitschrift* of October 24th, from which the following is abstracted:—

The current is collected at contact places arranged between the rails and projecting about 35 mm. above the street surface. The distance between these contacts is rather less than the length of the tramcar. An iron rail carried under the body of the car serves to collect the current; the rail glides over the contact cones and is longer than the distance separating each two contact cones, so that under ordinary working conditions the rail touches a new contact cone before leaving the old.

As will be seen from fig. 1, the contact rail carries on its upper part a series of electro-magnets connected together, the arrangement of the circuit being shown diagrammatically. The generator at the power station is represented by G; E is the motor on the car, and M are the electro-magnets which magnetise the contact rail, A A. The underground conductor is indicated by K, and S is the return by the rails. The contact cones, B C, as already mentioned, project a little above the surface of the track, whilst the rod or plunger, D, is underground and is capable of slight vertical motion. If there is no car over the contact cones, the iron plunger, D, in consequence of its weight, takes the lowest position, and is not in contact with the contact cones, B C. When, however, the magnetic rail, A, comes in contact with the contact cones, the plunger is raised by magnetic attraction, and in this way the circuit is closed. The circuit remains closed as long as the collector rail continues over the particular contact pieces for the time being; but as soon as the car passes along the magnetic attraction ceases, the plunger, D, falls by gravity into its original position, and the current is interrupted. Before this takes place, however, the connection between K and E, is established by means of the next contact cone in the direction of the car's motion; thus the passage of the current to the motor continues without cessation.

It is, however, in the constructive details of the system that Mr. A. Diatto claims to have effected improvements over other closed conduit systems. Fig. 2 is a cross section through the car and the magnetic collecting gear. As the weight of the latter amounts to 4 cwts. it is necessary to prevent any undue wear of the contact cones and rail, and for this purpose a portion of the weight is taken up by the stay-rods, *f*, and springs, *m*. At the same time this arrangement prevents lateral motion, although a slight longitudinal movement is possible.

Fig. 3 is a section through the contact cone which forms the top of a completely closed cast-iron box, P. The centre of this box is occupied by an iron case, R, which serves as a kind of cylinder for the reception of the plunger D. In order to strengthen the magnetic effect, the case, R, is surrounded by an iron ring, V, which is connected to the bottom of the box as shown. The case, R, is partly filled with mercury,



the quantity of which is so calculated that at the lowest position of the plunger, D, its weight overcomes the buoyancy.

The magnetising force required to raise the plunger is comparatively small, and the plunger rises immediately upon the rail coming into contact with the contact cone, C. It is, of course, very important that on the car passing along the plunger should at once drop into normal position. This object is attained by coating with copper the surfaces coming into contact, which renders impossible any adherence due to residual magnetism. The current is led through the case filled with mercury by means of the cable, K, which is laid underground in pipes.

The upper surface, B, of the contact cone is magnetically screened from the casing by means of the wooden ring, H. At the same time this ring serves also as an insulator between B and the surrounding earth. Mr. Diatto states that the elevation of the contact cones slightly above the street level does not in any way hamper the ordinary street traffic, and that the excitation of the collector only requires 250 watts.

INCANDESCENT LAMP EFFICIENCIES.

Although a great deal of discussion has taken place on the efficiencies of incandescent lamps, the actual results of tests on different makes have been difficult to obtain. One reason for this is the considerable expense attached to an extended series of tests. Suppose, for instance, that a dozen lamps are run for 500 hours from a supply company's circuit, this means that between 300 and 400 supply units are consumed if the lamps are of a nominal 16 candle-power. In addition to the cost of electrical energy, there is the labour of periodical testing and examination and the cost of the lamps themselves, for any test that may be entered upon must be made with lamps bought over the counter in the ordinary way, and not with samples supplied by the makers, if it is to be of real service in instituting comparisons.

Another feature that detracts from the importance and utility of trials so far made is the method by which different makes are designated. "Lamp No. 1," "lamp No. 2," and so on, may be convenient and serve as a mask to hide the origin of those lamps that are better or worse than the average, but what is really wanted is the data of impartial tests carried out on a sufficient number of lamps, and the figures for each placed against it, so that the user of lamps, or the central station engineer, can draw his own conclusions according to his experience, knowledge of the subject, and personal proclivities.

About the time that the Edison patent expired a couple of years ago, the question was whether the Edison-Swan lamp would be supplanted, or be able to hold its own. It was frequently said that the Edison-Swan lamp must easily hold its own against cheaper, and, presumably, inferior competitors, the makers of which entered upon manufacture with less experience. In central station practice, at that time, it was found that 70 to 80 watts for a 16 C.P. lamp was the rule, a 60-watt lamp being the exception, although, in 1891 and 1892, careful tests made by large London central stations showed 66 watts to be the average to start with. Free competition on the Continent had resulted in the production of a 3-watts-per-candle lamp, while 50 watts was the maximum power permitted by specification abroad for lamps of an average life of 1,000 hours. This was a saving of about 25 per cent. on the energy consumed during the life of a lamp, as the Continental 50-watt lamps did not increase appreciably in current consumption, compared with those then used in this country.

Some recent tests of English and Continental lamps show that the former are fast out-stripping the latter in all-round efficiency. As the prices at which 16 C.P. lamps are sold vary from 6d. to 2s., while they consume anything between 10 and 80 supply units during their life, the first cost of the lamp itself is generally of small moment compared with the cost of electrical energy. The unit may be said to vary in price from 3d. to 8d. in this country, but even at the lower of the two mentioned, the efficiency of a lamp is a much more vital point than a few pence more or less in the charge made for it by the manufacturer.

In the tests to which we have alluded, the lamps were bought over the counter in the ordinary way without anything being said as to the object of the purchase. Six lamps of 8 C.P. and six of 16 C.P., all intended for use on a 100-volt circuit, were subjected to a trial at this pressure, which lasted 600 hours. The necessary measurements from which the efficiency was determined were made by suitable instruments, whose accuracy was periodically checked against standards. From weekly observations the varying efficiencies were obtained, and from the figures for commencement, at end of 350 hours, and for 600 hours, as given by a contemporary, we have plotted the curves which accompany this article.

One of the first things that strikes us is the anomalous position of the Sunbeam lamp, as given for both 16 and 8-C.P. sizes. Inasmuch as the records show that no lamp of this make burned out during the 600 hours the tests lasted, we should be inclined to attribute the peculiarity to some circumstance, such, for example, as that the Sunbeam lamps tried were specially intended for long life conditions, and were hardly of a class with the others. Three sets of curves are given for each size of lamp; these show respectively the watts actually taken, the actual candle-power of the lamp throughout the period of experiment, and the watts per candle-power.

We have deduced the means for each diagram, and the curve marked "mean" will be found to exhibit a peculiarity, in that it is in all cases very nearly a straight line. Taking the 16-C.P. lamps, the Sunbeam requires the highest power, the old Edison-Swan coming next. Below the mean fall the new Edison-Swan and the Robertson; but these change their relative positions as time goes on. Coming to candle-power,

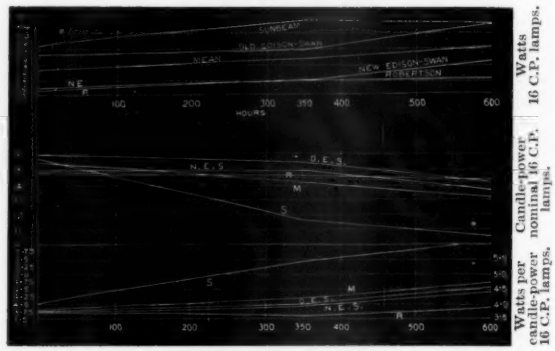


Fig. 1.

it may be noted that both old and new Edison-Swan and Robertson show higher C.Ps. than the mean, the new Edison-Swan having a curious bend in the curve (1) as it first rises and then falls. The Sunbeam curve falls markedly with duration of test. Constancy of candle-power is a feature that the supplier of electrical energy necessarily attaches considerable importance to, for the supply is frequently blamed if the effective lighting in a shop or room is found to fall off. Taking what is, perhaps, the most useful of the three diagrams, that of watts per C.P., we find the order of merit quite distinctly indicated, and where the Robertson lamp

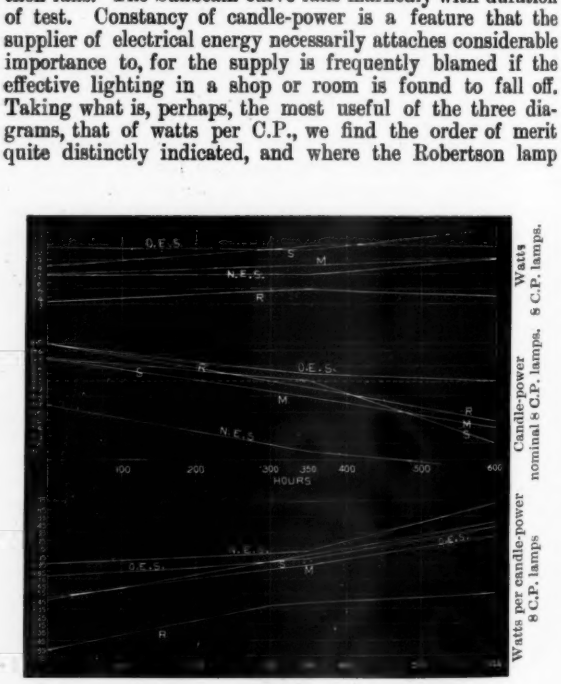


Fig. 2.

loses ground in virtue of its lower average C.P., it here gains owing to the small watts per C.P. It is somewhat curious that none of these latter curves intersect or cross one another.

That 8-C.P. lamps are intrinsically different in their characteristics from those of higher C.P. is made clear by an inspection of the corresponding three diagrams for the smaller size. Not only is the relative order changed, but curves before nearly straight are here bent, and those before passing twice through one value of C.P. are now found doing so only once. The curves practically speak for themselves, and may be taken are relatively correct. They afford ground for careful comparison, but into such a matter we hardly care to enter further than we have already done.

THE EXACT MEASUREMENT OF VOLTAGE, CURRENT AND RESISTANCE.*

By W. M. STINE.

An article by Mr. C. J. Black bearing this title appeared in the *Electrical World* of August 17th. It contained a further reference to an abstract, in the Digest for July 20th, of the "double loop" method employed by Mr. Thiermann for measuring high E.M.Fs. by the use of the standard cell. Mr. Black illustrated with a sketch a method which he devised and named in contrast, the "single loop" method.† This latter method contained a serious error which has seemingly passed unnoted. The matter might be passed over without further comment did it not involve a method for the measurement of current and E.M.F. of the highest value to engineers. In this case the method was wholly

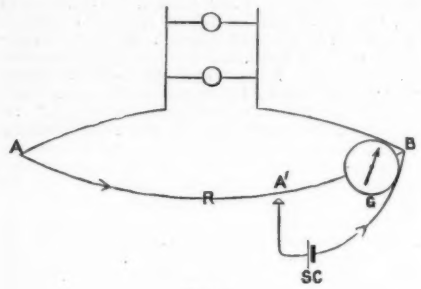


Fig. 1.

original with Mr. Black, who, strange to say, did not know of the potentiometer and its use until his attention was called to it by the writer.

The "double loop" devised by Mr. Thiermann is a needlessly complicated arrangement of circuits. It involves the use of numerous coils of accurately standardised high resistance and the unnecessary condition of keeping the standard cell on a closed circuit.

Mr. Black's diagram is reproduced in fig. 1; it will be noticed that the galvanometer is placed in the circuit, A B, this being the circuit over which the fall of potential is to be measured. No account has been made of the resistance of the galvanometer, which in this case is an integral part of the circuit. If the resistance of this galvanometer is very low it is possible to so adjust the varying resistances that no current shall flow through it, providing the internal

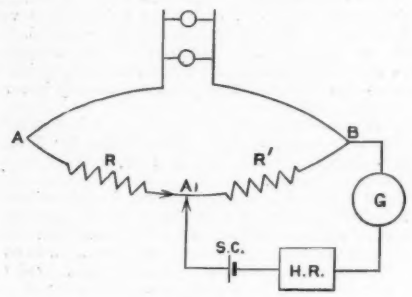


Fig. 2.

resistance of the cell is also very low, a condition which obviously does not obtain in cells of this type. All the current passing over R must then flow through the standard cell, which would not only ruin the cell but render its readings wholly valueless. In order to determine the P.D. between A and B the internal resistance of the cell must be known as well as its E.M.F. A millivoltmeter in shunt to A' B would yield far more accurate results.

The correct method is shown in fig. 2, which exhibits the familiar potentiometer scheme in common laboratory use. The contact at A' is moved along the resistance R, until a resistance, R', has been found over which the P.D. is the same as the opposed E.M.F. of the standard cell, viz.: 1·44 volts for a Carhart-Clark cell. When this equilibrium is reached, the galvanometer shows no deflection. The value of this method lies in the fact that it is a zero-deflection one. Calling the P.D. over A B, E, and the E.M.F. of the standard cell, E'; then R being the total resistance between A and B,

$$E = \frac{E' R}{R'}.$$

The standard cell must in all cases be so connected up that its E.M.F. opposes the direction of the current over A B, as shown. It should also have in series with it a high resistance, H R, of at least 10,000 ohms. Since no current flows over this circuit when the adjustment is completed, its total resistance is without any influence on the results.

The geometrical illustration of fig. 3 may make this method clearer. The resistance, R, is laid off on the line A B, representing the total resistance of the circuit over which

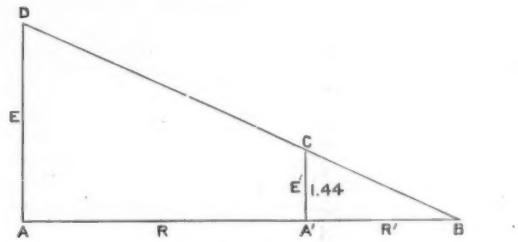


Fig. 3.

the fall of potential is to be measured. A' B is then laid off equal to R'. The perpendicular line, E', is drawn at A', to represent the E.M.F. of the standard cell. A line is then drawn through C, cutting the perpendicular erected at A, in a point D. Call A D, E. The two triangles, A' B C and A B D being similar.

$$\frac{E}{E'} = \frac{R}{R'} \text{ and } E = \frac{E' R}{R'}.$$

The potentiometer method is an exceedingly valuable one, and should be thoroughly understood by electrical engineers. By suitable modifications it may be employed for accurately measuring a great range of potential differences and currents. It is also a most excellent method for measuring very low resistances. In practice a specially designed resistance box, called a potentiometer, is employed. A number of modifications of the potentiometer were fully described in a recent paper and its discussion before the American Institute of Electrical Engineers.

* New York *Electrical World*.
† See Electrical Review for September 6th.

PROFESSIONAL ETIQUETTE.

In an article with the heading, "Dishonesty in the Profession," Mr. G. Emil Hesse recently said: "It should be the ambition of every man to raise his profession to a high moral level, and meet every attempt to drag it down with contempt. The sooner an engineer realises that he has a reputation to work for besides a living, the better for himself and for the profession that he belongs to." This is a fitting conclusion to a lament over the custom that has ruled in America of consultants accepting commissions, but it also expresses very clearly what we have been striving to make clear to our professional brethren. Now, we are asked, what views may be consistently held on the "consultant journalist?" Such a question shows at once that the engineer fails to grasp the bearing that etiquette should have to the professional man. The consultant may be a journalist, and the journalist a consultant, and many instances of well-known men having held both positions with honour to themselves and benefit to the profession to which they belong might be cited. There is

nothing incompatible in the dual qualification, but it is quite another thing when the ostensible journalist becomes a vendor of commercial appliances, competing with those who at other times, and under other circumstances, are his clients. The distinction is so obvious, that it ought not to require enunciation. Neither a journalist nor a consultant can afford to neglect, even in so little, the attributes of his calling, and the better the one, the better the other, things being equal.

As we again allude to this question, there is a phase of it that might be mentioned. It has become the custom for many associates and others in our scientific institutions to mislead the public by placing after their names letters that do not truly belong to them, or show the exact class to which they are entitled to subscribe themselves. On calling the attention of the secretary of one of our institutions to this point, we were told that he, too, was continually noticing the fact to which we have alluded, and at one time suggested to his Council that it might be desirable to do the same as the Institution of Civil Engineers, viz., indicate exactly the designatory letters which each class of members should be entitled to place after their names. It was not at that time thought necessary; but we understand that attention will again be called to the subject, when we hope some action will be taken. An Associate of an Institution that does not possess a class of Associate Members, and who uses the letters "A.M.***," can hardly be credited with anything less than either ignorance of their significance, or with a desire to transfer himself in the opinion of the public at large from the class in which he is to a higher grade. The Institutions of Civil and of Mechanical Engineers possess classes termed "Members" and "Associate Members;" other bodies do not, and it would be an improvement in some quarters if the fact were noted.

THE ARC LIGHT.*

By Prof. SILVANUS P. THOMPSON, D.Sc., F.R.S.

Lecture I.—Delivered January 14th, 1895.

PHYSICS OF THE ARC.

It is narrated of Faraday that he had a particular dislike for what he called "doubtful knowledge;" and it was one of his great achievements in electrical researches to clear up a number of things that came under that category. Some small fact had been discovered, it was obscure, it was not correlated to anything else. So long as it was not correlated to anything else, and not explained, it was unsatisfactory. And though science has gone on since Faraday's time, has developed, extended itself, become correlated all round, while now there are a hundred workers where formerly there was but one, still there are some branches of science in which knowledge is still in a very doubtful state. Into the category of doubtful knowledge I venture to put that phenomenon which was discovered by Humphry Davy during the last year of the old century, and received the name of "the arc."

Although arc lamps are to be counted by the million, though the arc light is used publicly in every town and city, though electrical engineers handle it every day, yet it still remains to be true that on the subject of the arc itself as a physical phenomenon, those of us who know most feel ourselves to be very ignorant. So much is still obscure and unknown, that—in spite of the researches of many workers—the physical nature of the arc is still a mystery. Many, however, of the complications that beset the enquiry have been gradually unravelled, and every fresh discovery brings the workers nearer to the explanation of that which is still unexplained.

To the physics of the arc, then, we devote this first lecture of the present course; the optics of the arc will claim our attention in the second; while the third lecture will deal with the recent developments in the mechanism of arc lamps.

Early Discoveries.

To introduce the subject of the physics of the arc I will begin at the beginning, and briefly recapitulate the things which were discovered in the first instance. It is sometimes said—and you will find it repeated in text-books—that the discovery of the arc dates from about 1809. I venture, however, to put the date earlier. It was in June, 1800, that Volta wrote an account of his then newly-discovered pile to Sir Joseph Banks, the then president of the Royal Society. The pile having in that way been made public, a few workers in science immediately precipitated themselves upon that invention, and tried to find out all that could be found about voltaic piles. Amongst those who thus set to work to build voltaic piles for themselves was Humphry Davy, then apprentice with Dr. Beddoes, of Bristol. In September, 1800, Davy recounts how he was able to produce sparks that were visible in daylight from the discharge of his primitive pile; and he found in trying sparks between terminals of different materials that those sparks were of different degrees of brightness. Amongst other materials that he names, he mentions that the bright spark visible in daylight was obtained by using well-burnt charcoal. He found that to render charcoal well-conducting it must be hard, dense, well-burned, so as to be metallic in lustre, and, best of all, if it were suddenly quenched in quicksilver. This early experiment of Davy's is recounted in the October number of *Nicholson's Journal*, to which it was communicated in September. Within one year several other accounts are to be found. In the *Philosophical Magazine*, in the February number for 1801, Mr. Moyes, of Edinburgh, narrates how he had produced sparks in broad daylight from a pile with some 60 or 70 elements. Then we find Davy again (having in the meantime removed to London, and become lecturer at the Royal Institution) describing, in the very first volume of the *Journal* of the Royal Institution, how he also had obtained sparks of vivid brightness, using still pieces of well burned charcoal. He describes an apparatus for taking the spark in fluids, and he continued to show this in his lectures on electricity. In that same year—1801 or 1802—Tyndall records that "Davy showed the carbon light with a battery of 150 pairs of plates in the theatre of the Royal Institution." Some six or seven years ago I was hunting up in the British Museum, for an entirely different matter, some of the early numbers of the *Journal de Paris*, and in the course of that search I came across something I had not at all expected. Under the date 22 Ventôse, An. X. (March 12th, 1802), I found the following entry:—

"Le citoyen Robertson, auteur de la fantasmagorie, fait dans ce moment, des expériences intéressantes, et qui doivent sans doute avancer nos connoissances sur le *galvanisme*. Il vient de monter des piles métalliques, au nombre de 2,500 plaques de zinc, et outant en cuivre rosette. Nous parlerons incessament de ses résultants, aussi que d'une experience nouvelle qu'il a faite hier avec deux charbons ardens. Le premier étant placé à la base d'une colonne de 120 élémens de zinc et argent, et le second communiquant avec le sommet de la pile; ils ont donné, au moment de leur réunion, une étincelle brillante, d'une extrême blancheur, qui a été aperçue par toute la société. Le citoyen Robertson répétera cette expérience le 25."

This same Robertson was a Frenchman of Scotch extraction, whose name comes into the outskirts of science in two or three ways. He was the man who introduced the phantasmagoria, and visited London with it at a later date. It is also said that in the same year, 1802, two other persons showed the carbon light, a German of the name of Curtet, and Ritter, of Jena, the famous experimenter upon the polarisation of copper plates; but the references are so scanty that one cannot verify the fact. But it is quite certain that in those two or three years of the century it became perfectly well known that a light could be produced in that fashion between two pieces of charcoal.

I may here take two pieces of charcoal well metallised, and connecting them to the wires from a powerful source of current I will perform Davy's fundamental experiment by putting them together, and then separating them to a distance of about $\frac{1}{4}$th inch apart from one another, when at once we get this little flame of dazzling brightness between the two. The flame in this case is really very bright, both the tips of the carbons themselves shine brilliantly, and the flame itself, when using soft carbon of this kind, is very bright indeed. Holding the pencils horizontally, as Davy did, the flame is seen to take an arched form, as the result of the ascending air current. This circumstance originated the name *arc*, which we retain, though now-a-days we hold the pencils vertically one above the other, and have no arch.

If anyone doubts still that the arc light was a known thing before 1808, let him look at this book, John Cuthbertson's "Practical Electricity and Galvanism," published in 1807, wherein, on page 260, there occurs the following:—

"*Experiment* 209, *Deflagration of charcoal by galvanic action.*—The charcoal for this experiment must be made of some very close-grained wood, such as boxwood or lignum vitæ, well charred, cut into pieces about an inch long, one end being scraped to a point, and the other so that it can be held by a port-crayon fixed to the end of one of the directors; then approaching the point of charcoal to the end of the other director, light will either appear, or the charcoal will be set on fire. The particular management required should be obtained by trials. The light when properly managed, exceeds any other artificial light ever yet produced."

Further on, at the last page of the book, the very last sentence runs as follows:—

"The quantity of electric fluid given out by the galvanic trough when compared with the quantity given out by an electric machine is worth attention. The deflagration of charcoal (experiment 209), which has been accomplished by the galvanic trough, has never been effected by common electricity."

Now, in those early years when Davy was showing this experiment at the Royal Institution, and other people were repeating it, there does not appear to have been any very careful distinction drawn between the mere spark obtained by breaking the circuit between the points, and the continuous flame, which, as I have shown you, can be produced by putting the points together and then separating them. If I steady my hand on a stand and hold the points a little distance apart, I get a flame which persists, although the carbons no longer

* Cantor Lectures, from the *Journal of the Society of Arts*. References to this series of Cantor lectures will be found in the Electrical Review for January 18th and 25th, and February 1st, 1895.

touch one another. If I merely put them together and separate them wide asunder, I get a momentary spark. It is not very clear from the records that the permanent flame, what we now call the arc, could be obtained; it is rather implied than described. The term "deflagration," used by Cuthbertson to describe a phenomenon which could not, as he plainly says, be produced, as momentary sparks can, by "ordinary electricity," is decisive. However, from the year 1808, there is no question whatever on that point. It was in that year that Davy drew up a kind of circular, addressed to the managers of the Royal Institution, saying that he hoped great things in the relation of electricity to chemistry to come from the voltaic pile, and begging them, if possible, to provide the means for purchasing a much larger battery. As a matter of fact, that famous battery of 2,000 cells was obtained by private subscription; and with this battery of 2,000 cells it was that Davy produced the phenomenon that created so much attention, viz., the production of a permanent flame of a great length and dazzling brightness arching over from one piece of charcoal to the other. If one substitutes for the comparatively soft charcoal that Davy first used, and that the earlier experimenters used, one of the hard carbons of the modern sort, one can manage the flame a little more conveniently. It was well known from about 1820 that the hard carbon obtained from the inside of gas retorts was a really good conductor of electricity compared with charcoal and many other things. It was in that respect comparable to the metals, and indeed, by Babbage and Herschel the hard retort carbon was actually classified amongst metals in conducting power. Hard retort carbons were introduced for the purpose of battery plates a little later by Walker, and about 1834 were used by Grove, when he wanted to employ nitric acid. He found that nitric acid would dissolve copper or iron or silver, such as had been used in some of the earlier voltaic cells, and he was compelled to employ some materials which nitric acid would not attack. He employed both platinum and retort carbon cut into slips. But his battery became known as a platinum battery, and when, in 1843, Bunsen returned to the matter, and employed carbon, many people imagined that carbon was Bunsen's invention for the purpose. At any rate, the use of hard carbon was coming in use into the arts. Foucault, in 1843, found that hard carbon sawn in strips was a better material than charcoal for producing the arc light, and artificial carbons were being made. By this time Bunsen himself had suggested the moulding of materials for the making of battery plates. Several patents were taken out for making artificial carbons, by Greener, Staite, and Jabez Church, in England, and by Le Molt, Archereau, and several others in France. One finds, in fact, that the electrical industry was being provided with the very material required, a hard carbon of good conducting qualities. About 1844* Foucault definitely proposed the use of pencils of retort carbon for the purpose of making the arc light. It was in 1846 that the first mechanical arc lamp was combined by William Edward Staite. Staite was one of those men whose inventions miss fire by being much before their time. He not only devised the necessary mechanism for an arc lamp, but proposed, among other things, to use two carbons parallel to one another, exactly in the same fashion that Jablochkoff did some 30 years later. Staite made a number of suggestions and improvements in detail, but does not seem to have worked much at the phenomena of the arc itself. Others, however, worked at it; Grove, the sole survivor of all the men of that time, happily still with us, not then a judge, made some experiments on the loss of weight of the carbons, to find out how much carbon was consumed by the light in a given time. He also tried other materials than carbon, and found that the addition of volatile matters, such as sodium or potassium or their salts increased the length to which the flame could be drawn out without breaking when supplied from a given battery. Daniell made some experiments, and found amongst other things that if you took your carbons and produced the arc, and let the tips get very hot, and then separated them so that the light goes out, and bring them near together, they still do not light unless you bring them into actual contact for an instant. But Daniell found that they could be made to relight by simply passing the spark from a Leyden jar discharge across—to begin the discharge, as it were. This was rediscovered by several persons later: Herschel, Van Breda, and Fusinieri all claimed to have discovered the rekindling of the arc by means of a spark from a jar. I here repeat the experiment, using a little Wimshurst influence machine to charge a suitable jar. Even Hertz waves can kindle the arc under favourable circumstances. De la Rive experimented with the arc, and examined various other phenomena, including the beautiful rotation of the arc round an iron pole, under the influence of magnetism, which had first been observed by Walker. Foucault, in 1844, made the observation that if the current was passed to form an arc between carbon and silver, the arc was unstable; whereas if the arrangement was reversed, so that the current flowed from silver to carbon, a long and stable arc was produced, giving out that magnificent green light which is characteristic of the spectrum of silver. He made the acute suggestion that the stability of the arc depended on the volatility of the material used as poles. He also drew attention to the action of the heat of the arc in metamorphosing retort carbon from the anthracitic into the graphitic state.

Before I go any further I may mention several additional points that were discovered in those early years. One of the first things Davy discovered was that the arc would burn under liquids. I will take these two carbon pencils and dip them into a vessel containing paraffin oil. On touching them together and separating them, I obtain a fitful, uncertain light; there is a great deal of heat produced and it gives off vapour, but as long as the oil itself remains cool, there is no fear of the vapour taking fire. The light is also toned down to a more agreeable golden tint than is the case when one takes the arc in air. If I put these carbons down into water, and in the same way make contact, I get a whiter arc, which is also still more fitful. A quantity of gas is given off, some of which is mere steam, which condenses very rapidly, some is hydrogen, some is oxygen, and there are some compounds of carbon and oxygen also given off.

* *Comptes Rendus*, xviii., p. 696, 1844.

Arcs between Metal Electrodes.

Returning to the arc in air, if I were to replace one of the two carbons by a bit of metal, I should get a very different effect. It is impossible to get a very steady arc between two pieces of metal, or even between a piece of carbon and a piece of metal. The kind of arc one gets depends very much on the metal one uses, and also on whether one is employing a metal as a positive or negative electrode. Here, for instance, I am using a carbon rod for one electrode, and a bundle of iron rods for the other. There is an arc between the iron and the carbon, and the iron deflagrates off in a beautiful way in a fountain of ruddy sparks. It looks much more dangerous than it really is. If I take copper I get a very uncertain and flickering light, while the arc is of one colour if I employ the carbon as the negative pole, and another colour if I employ it as a positive pole. The copper disintegrates off more readily if it is made the positive pole than if it is made the negative pole. I am now employing solid iron; it does not deflagrate so much as the iron wire that I had before. Now I will take zinc, and I obtain this horrible roaring, hissing arc. But I may show you zinc under more favourable conditions. I will replace my metal electrodes by carbon ones, and take an ordinary stick of zinc, such as is used in battery cells. I will then make contact to it by touching it with these two carbons. If I make contact a moment with both, and then remove one of them, I shall have an arc between the carbon and the zinc. First, I will so operate that the zinc is the positive, and the carbon negative. Then I will reverse the operation, so as to have the zinc negative and the carbon positive. In one case the arc is much bluer than in the other, and it hisses much more. The arc is quieter if the carbon is positive and the zinc negative than when the zinc is positive and the carbon negative. If I employ quicksilver in the same way, I shall obtain an arc which will differ in brightness according to whether the quicksilver is positive or negative. More vapour is given off when the quicksilver itself is the negative pole. The quicksilver now is positive; that is a yellower light, and not so bright. The vapour is horribly poisonous, so we will not continue the experiment long. Professor Way, an inventor of a mercurial arc lamp 30 years ago, lost his life by the poisonous fumes.

Arcs and Sparks.

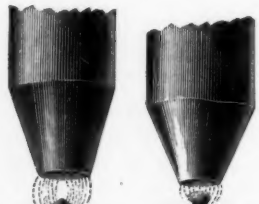
Many of the earlier experimenters are extremely vague in the way they describe the arc. They do not give definite statements about the actual amount of the current they employed, and one can only judge of the electromotive force at their disposal by counting the number of cells, and trying to find out what sort of cells they had. Modern science gives us the opportunity of being more precise. We can say exactly what electromotive force we are using, and how much current we are actually sending through an arc. Such arcs as we have in modern practice require an electromotive force of something more than 20, and something less than 70 volts—varying generally from 40 to 50 in the case where continuous currents are employed. Under those conditions the arc produced is a very different phenomenon from that which is produced by sending a much smaller current at a much higher pressure; for then the discharge takes the form of a thin spark. If one sends a spark or a succession of sparks from an induction coil, or from a large influence machine between two brass knobs at a distance from one another in the air, the discharge that one gets resembles the arc, to some extent, but really is a very different phenomenon. The discharge one gets in vacuum-tubes, between terminals of platinum, across the highly attenuated air, is again a different phenomenon. For in neither of those two cases does the material of which the electrodes are formed play any important part in the phenomenon. In these cases, as we now know, from the recent researches of Schuster and of J. J. Thomson, there occurs an electrolysis of the gaseous medium. What you produce in these cases is a discharge carried on by gaseous particles, which move about, no doubt, and pass to and fro, and shine, but the light mainly comes from the volatile or gaseous particles, and does not come from the solid matter which constitutes the electrodes; whereas, in the true arc itself, the main light comes from the solid matter of the electrodes, and not from the gaseous matter of the flame in between. So in the production of the arc, a great deal depends—in fact, everything depends—on what that solid matter is. By universal consent, carbon is found to be the only workable material. Moreover, the carbon is consumed at one or both of the electrodes during the continuance of the arc; this circumstance alone constitutes a distinction between the two cases. Now the normal sort of arc produced between two carbon pencils is a thing that will engage our attention far more than any other arc, because it is the normal arc produced between two carbon pencils, which is of industrial value. The others are mere curiosities, so to speak; they may hereafter have an industrial interest, but at present they have only an abstract scientific interest.

The Normal Arc.

What, then, are the conditions of producing the normal arc? We have carbon pencils of the purest and best carbon one can obtain. In most cases one wants a good conducting carbon, and a fairly hard one. The pencils must be put together, and after having been put together, they must be separated to the requisite distance; then the flame springs forth. In technical language "the arc is struck." The tips become brilliantly white hot: one of them—viz., the positive one—burns away faster than the other. They assume different shapes, and the light is found to come almost entirely, by far the greater part of it, at any rate, from the white hot end of the positive carbon.

To examine the conditions of the arc, a lens is arranged so as to

throw a magnified image of the arc on the screen, where we can see the shape without being blinded. You will now see in the image on the screen what justifies my statement that the light does not come from the flame in between the two. The arc is now burning steadily and silently; the current being sent in so as to flow downwards. The top carbon, which is therefore the positive electrode is seen, fig. 1, to have assumed a flattened form. That is the form assumed by the positive electrode, after being allowed to burn for a few minutes. There is a sort of lightly hollowed crater full of light. The current is coming out from that crater into the flame. There is an almost invisible pale blue flame in between the carbons The lower pencil has taken a more pointed form, a sort of peak having formed upon it. This negative peak also shines white-hot, but we do not get so much light from it as from the other, nor is its light so white in quality. If I hold the carbons at a proper distance apart, you will notice that the arc burns quite quietly, and we have a silent flame. If I were to pull the top carbon up too much, and make the arc too long, it would begin to flame more and to roar, and would probably go out. On the other hand, if I make the arc too short, it would begin to hiss. Sometimes it hisses persistently when



Silent. Hissing.

Fig. 1.

the arc is too short. You then notice another phenomenon taking place, viz, that the negative tip, which ought to be burning away while keeping of a peaked shape, acquires little lumps. There are little projections, technically known as "mushrooms," which appear upon the peak. These mushrooms always occur when the arc is hissing. When the arc is burning silently the mushroom disappears, burning away until the negative carbon comes to its proper conical shape. In the case where alternating currents are used, there is no such difference in shape between the two tips, as we shall see in due course. For the present I am considering the arc as produced when the current is of the continuous kind.

There is some difference in the circumstances attending the production of the normal arc. In America, the practice is to use two pencils of equal size, and of the same quality of solid carbon, usually coppered, and to work with arcs about $\frac{1}{10}$th inch long for a current of 10 ampères; many lamps being run in series. In England, where parallel running of lamps or groups of lamps is more common, the practice is to use as upper pencil a carbon of larger size than that employed for the lower pencil; and the upper carbon is usually "cored" (*i.e.*, made tubular and filled with a core of softer quality); while the length permitted the arc seldom exceeds $\frac{1}{8}$th to $\frac{1}{2}$th inch.

Now there is a great difference in properties between the arc that hisses and the arc that is silent. Not only have you this characteristic difference in shape, but the light is distributed differently from the surface. The quantity of current consumed, other things being equal, is different, and in fact, as I shall show presently, the conditions are completely changed. Now I would like you to contrast the effect produced in an arc burning quietly in that way with what one gets if one tries to form a current between two carbons in the same fashion at a distance from one another, using also a steady current, but employing much greater electromotive force. I have the means here, by a small continuous current transformer, of generating a small current of about 1 ampère, at a pressure of 1,000 volts. The wires from that small continuous transformer are joined up to two carbons here. This long flame is obviously quite a different thing from what one gets by using the same amount of power in the form of a larger current at a smaller pressure. It is totally different from a 10-ampère arc at 100 volts, or a 20-ampère arc at 50 volts. There is a little streak of light, but that is really more of a flame colour, and the light from the carbon tips is comparatively insignificant.

Relations between Voltage, Resistance, and Length of Arc.

As soon as electricians began to think about making arc lamps, they had to discuss how much current to provide, and at what pressure. They had to decide as to the thickness of the carbons that was required, and what length they must allow. In fact, they had all manner of things to find out, and amongst the things they did experiment upon was—What was the relation between the electromotive force, the current, the resistance, the length of the arc, and the size of the crater. They came across a very strange fact. If you consider the arc as a conductor, as a column of flame or vapour conducting the current, you will find that it does not follow the laws of ordinary conductors; when you double its length, it does not offer twice the resistance. It was a very puzzling fact, and the Swedish physicist, Edlund, who first drew attention to this fact, thought it could be explained by supposing that in the arc itself there is a sort of polarisation as there is in a secondary battery when you are charging it, or as in a voltameter when you are decomposing water.* This polarisation manifests itself as a back electromotive force opposing the current. Many researches have been made upon this matter, and I have tried to tabulate them:—

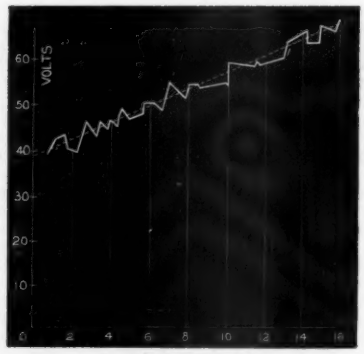
Formulæ Suggested for the Arc.

Edlund	$r = a + b\,l$
„	$v = c\,a + c\,b\,l$
Ayrton and Perry†	$v = 63 + 2{\cdot}1\,l$
Frölich ...	$v = m + n\,l$
S. P. Thompson	$v = m + \frac{n\,l}{c}$
Mrs. Ayrton‡ ...	$v = \alpha + \beta\,l + \frac{\gamma + \delta\,l}{c}$

Values of the Constants m and n (l being Expressed in Millimetres).

Authority.	Date.	m.	n.
Ayrton and Perry	1882	63	2·1
Frölich	1883	39	1·8
Penkert	1885	35	1·9
Von Lang	1885	39	...
Von Lang	1887	37	...
Cross and Shepard	1886	37 to 39·7	1·9
Luggin...	1887	40·04	1·77
Uppenborn	1888	40 1	2·24
Duncan and Rowland	1892	40·6	1·6

The electromotive force applied to the arc to drive the current through we may call v; it may be otherwise described as the difference of potential across the carbons. Edlund found it to consist of two parts, a part independent of the length, and another proportional to the length, l, which symbol, in these formulæ, stands for the length in millimetres. As Edlund wrote the formula, it was an expression for the apparent resistance, r, in terms of the length, l, and two constants, a and b. This we may transform into an expression for the voltage, v, by multiplying both terms by the current, c, as in the second line in the above Table of formulæ. The terms, $c\,a$ and $c\,b$, are respectively the same things, as are denoted by m and n in the formula used by Frolich. They simply mean that the voltage consists of two parts, one a constant, the other varying



Length in millimetres.

Fig. 2.

(like a true resistance) with the length of the arc. Edlund did not himself determine the numerical value of those constants; they were not determined, as far as I know, until 1882 or 1883, and the earliest determination of that constant and the variable part is, so far as I know, due to Profs. Ayrton and Perry, but I do not understand the figures in their paper, because they make out that the constant part is 63 volts, and the part which is proportional to the length is in volts 55 times the length in inches, minus a correcting term (omitted

* Edlund considered that he had proved by experiment the existence of a measurable polarisation a fraction of a second after the current had been cut off. Although this persistent back electromotive force was confirmed by Latchinoff, more recent experimenters such as Stenger and Lugger, deny its existence.

† Their formula had a small correcting term here omitted.

‡ Added since the delivery of the lecture.

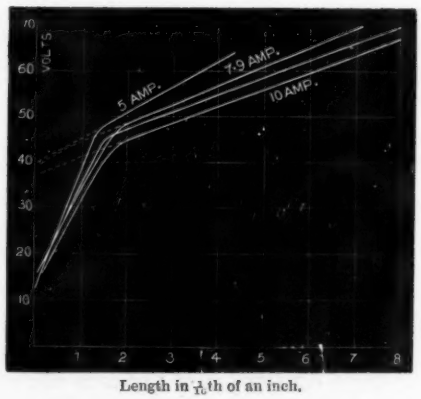
from the formula for simplicity). The diagram which they gave, which corresponds to these figures, is, to me, entirely unintelligible, unless one supposes that, in 1882, the voltmeters employed measured the voltages nearly twice too high. The other figures here given, with their dates, show a much more consistent tale: Frölich, in 1883, found the fixed part 39 volts, and the variable part to be 1·8 times the length of the arc in millimetres; Von Lang found 39 or 37 for the fixed part; Penkert found 35; Cross and Shepard 37 to 39·7; and Luggin over 40.

If we take 39 as about the average of these, we shall not be very far wrong. Now, these 39 volts that one finds as the fixed part, apparently have something to do with the properties of the carbons, for if you try arcs with any other material than carbon you get also a fixed number, but a very different one. And if you put into the carbons any other material to make them longer, for instance, soda, potash, alumina, or any metallic salt or metal, the maximum flame may be longer under different conditions, but as a matter of fact the light will be less for a given consumption of energy, and the fixed part of the voltage will also be less. Probably these low numbers of 35 and 37 are due to the presence of impurities in the carbons.

Now, I should like to illustrate this matter by a diagram or two, in which some of these researches are set forth.

Fig. 2 is a diagram illustrating the results of Frölich's researches. The length of the arc from the crater to the peak is plotted out horizontally, the voltage is plotted vertically. In the shortest arc which could be used without hissing, Frölich found about 40 volts to be the amount of the electromotive force which maintained the arc. As he lengthened the arc, the voltage went up in this slightly irregular way. The irregularities may be due either to bad quality of carbon, or to the circumstance that the current was not maintained constant, or possibly to the experiments being made too rapidly to allow the arc under each of the successive conditions of length to burn long enough for the electrodes to assume the forms which they would acquire if left long enough. You will note that his curve slopes as though it intended to come down to 39, when the arc is of no length at all. To make a flame of this sort carry a current across from the positive to the negative carbon requires 39 volts, and the additional voltage indicated by the additional height to any point on the sloping line is that which is necessary to drive the current through the flame when the flame has various lengths. The longer the flame, the more are the additional volts required.

Fig. 3 relates to some of the researches of Cross and Shepard. These researches are in many ways very full. For the first time statistics are given, not only for silent arcs, but for hissing ones. They made a number of determinations, trying various kinds of carbons, and also tried the effect of putting in different materials,



Length in $\frac{1}{10}$th of an inch.

FIG. 3.

such as soda and potash. The experiments shown in this figure relate to one particular kind of carbon, but using currents of different strengths; one set when using a current of 5 ampères, and another when using 7·9 ampères, another 10 ampères; and they found that if they pursued the thing down, beginning with a long arc, and gradually shortening it, and adjusting the current to the same amount as before, that the voltage fell, in all cases, as though it intended to go down to 39 volts, when the length is reduced to an appreciable amount. But as soon as the arc begins to hiss, then the curve changes; there is much less electromotive force required to maintain the hissing arc than the silent arc, and the hissing arc appears to point somewhere to 15, 14, or 13. The hissing arc is very unsteady, however, and the exact form of the curve is uncertain here. To maintain a hissing arc wants very much less electromotive force than to maintain a silent arc of no appreciable length; but in each case there is a part of the voltage fixed, and a variable part depending upon the length of the arc. I might give you, in similar curves, the results of nearly all these experimenters; but I should be only giving you the same thing over and over again.

I have found that, by gently blowing sideways on the arc, so as to cause it to take a longer curved path, its resistance is increased; it then requires a higher voltage to maintain the current. The arc is indeed curiously sensitive to winds and draughts. It can quite easily be blown out like the flame of a candle.

(To be continued.)

THE PORTRUSH FATALITY.

REPORT OF A LOCAL INQUIRY HELD AT PORTRUSH, IRELAND, ON SEPTEMBER 25TH AND 26TH, 1895, INTO THE CAUSES OF A FATAL ACCIDENT TO A PERSON NAMED THOMAS WALNE ON THE GIANT'S CAUSEWAY, PORTRUSH, &C., TRAMWAYS.

To the Assistant Secretary, Railway Department, Board of Trade.

SIR,—I have the honour to report that, as appointed by the Board of Trade, I held a local inquiry as above. The inquiry was held in the Town Hall, Portrush, and occupied two days.

The complainants, on whose application the Board of Trade decided to hold this inquiry, are certain ratepayers of the district traversed by the tramway.

Mr. William Moore, barrister, instructed by Mr. T. Taggart, solicitor, appeared on behalf of the complainants. Mr. H. W. Leech, solicitor, on behalf of the tramway company.

Besides hearing statements and taking evidence, I carefully examined the line throughout, and the station where the electric power is generated.

Description of the Line.

The tramway upon which the accident occurred is a line six miles in length, constructed under powers given by the Giant's Causeway, Portrush, and Bush Valley Railway and Tramways Act, 1880, between the town of Portrush and Bushmills, along the side of the public road, and an extension which is more properly a railway, two miles in length, across private property, to a terminus in the immediate vicinity of the Giant's Causeway.

The line is worked chiefly by steam engines, but in addition electric motors are provided in a few of the cars and electric power is supplied to these except for the portion of the line within the town of Portrush where steam power is used exclusively. The electric power is supplied from a generating station at some distance from the line by means of overhead wires, the energy being obtained from water power.

The charged conductor, by contact with which the electric current is transmitted to the motors on the cars, is a stiff iron rail supported at a height of about 18 inches from the ground on the side of the tram rails next the hedge or boundary of the road. At road crossings and at gateways into fields, &c., the conducting rail is omitted for the requisite length, and connection effected by means of an underground cable across the break of continuity. The return circuit is provided in the usual way by means of the tram rails, copper bond wires being used to connect together the several lengths of rail.

No attempt has been made to secure the public using the road or cattle driven along it from contact with the charged conductor rail.

Summary of Evidence.

The evidence submitted on behalf of the ratepayers was chiefly directed to the support of their contention that the charged rail in its present condition constituted a danger to horses and cattle, and an annoyance to the public using the highway. Evidence was given of the death from electric shock obtained from contact with the charged conductor of this tramway at various dates since the line was opened, of four horses and five head of cattle, besides injuries to other animals, and that in some cases payments had been made by the tramway company to the owners by way of compensation.

This evidence was not seriously rebutted by the tramway company, whose principal scientific witness, Prof. G. F. Fitzgerald, M.A., F.R.S., of Trinity College, Dublin, admitted that in the present state of the line there is danger to cattle or horses driven along the road.

The complainants relied upon the finding of the coroner's jury as proof that the unfortunate death of Mr. Thomas Walne was due to electric shock.

The tramway company, however, produced the principal witnesses examined before the coroner, to whom I read their evidence as given in the copy of the proceedings at the inquest supplied by the complainants, which they declared to be correct.

I also examined these witnesses myself, and would draw special attention to the statements of Miss E. J. Adair that Walne was breathing naturally, and took brandy after the fall, turning up his face to obtain it; and of Dr. Huey, that, in his opinion, if there had been no current on the rail the man would be alive now.

The circumstances of the accident, so far as I was able to arrive at them, are that the deceased, Thomas Walne, was riding a bicycle along the road from Bushmills to Portrush about 7.30 p.m. on August 26th, 1895. At a short distance from Bushmills he attempted to turn his bicycle on to the tramway, which is at this point separated from the ordinary roadway by a stone curb rising a few inches above the roadway. The machine, striking against this curbstone, was upset, and Walne was thrown violently over the tramline, and fell across the raised rail, which was electrically charged at the time, so that this rail was across the lower part of his chest, his hands and head probably touching the damp grass on the bank on the far side of the raised rail, one of his legs over the bicycle and the other under it, and the bicycle lying across the tramway rails.

He was heard to shout three times, as if in agony.

His companion, who was about 100 yards behind him at the time, tried to pull him off, but was at first unable to do so on account of the shock he himself sustained. Finally, he accomplished his purpose by wrapping his mackintosh round his hands.

Walne was then carried across the road and supported while brandy was administered to him. He appeared to be conscious, and was breathing naturally. He was able to swallow the brandy.

Shortly afterwards he was removed to the station at Bushmills, where he was seen by Dr. David Huey. He had then ceased to

breathe, but the heart was beating slowly. Artificial respiration was resorted to without effect, and he died about half an hour after the fall.

Dr. Huey examined the body, and found several marks of burning on and below the breast, but no post-mortem examination was held.

The complainants also produced scientific evidence proving disregard by the tramway company of the regulations for electric working imposed by the Board of Trade, and this evidence I am able to supplement from my examination of the line and generating station.

This witness, Mr. A. E. Porte, electrical engineer, of Dublin, also suggested that the existing danger might be remedied by covering in the charged rail so as to prevent accidental contact with it, that the turbines at the generating station should be governed automatically, and that there should be a self-recording voltmeter at the station at Bushmills open to public inspection. I will deal with these suggestions later.

The evidence produced on behalf of the tramway company was to the effect that in numerous cases shocks had been received by human beings from the charged rail, in some instances contact being made for several minutes, without permanent injury.

Inspection of Line and Generating Station.

This inspection was made on the afternoon of the 25th inst. I found that the regulations imposed by the Board of Trade had been disregarded in many particulars, as follows:—

Regulation V., entirely disregarded.

Regulation VI., do.

Regulation VII. I do not consider the voltmeter in use efficient for the purpose, as although it appeared to be approximately correct in its indications, it was far too small to be read conveniently at the distance at which the man stands to regulate the current.

Regulation IX., entirely disregarded. Additional regulation as to notices along the line insufficiently attended to. I only saw three such notice boards, and the inscription on these was almost obliterated.

Byelaw IV., disregarded in the cars I saw.

I took several tests of the electric pressure at the station at Bushmills, being the nearest point of the line to the generating station, and at the generating station itself.

The volts on the line varied considerably, the highest reading I obtained being 310, and the average about 290.

At the station the readings were much the same.

As the regulation was entirely by hand, I tested what would be the effect produced by ordering the attendant to leave the regulating wheel alone, as if he had been suddenly incapacitated.

Under these circumstances, the pressure only rose to about 320 volts.

The water was, however, rather low at the time, and at periods of full supply no doubt a greater rise of pressure might be produced; indeed, Mr. Boyd, the inspector to the tramway company, stated that the highest reading he had observed at any time at the generating station was 360 volts.

The charged rail appeared to me to be a decided obstruction, especially at road crossings, and in front of field gates, &c.

It seemed to me hardly practicable for a man to drive a herd of cattle along the road, or into a field abutting on it, without great risk of one or more animals receiving a shock.

Conclusions.

Having carefully considered the evidence produced at the inquiry held by me, and the observations made at my own inspection, I am of opinion:—

1. That Thomas Waine died from the combined effects of severe injury caused by the fall across the rail and electrical shock.

2. That the tramways in question are at present, when the insulated rail is electrically charged, a danger to the public and an annoyance to the ordinary traffic.

3. That the Giant's Causeway, Portrush, and Bush Valley Railway and Tramways Company, have not paid sufficient attention to the regulations imposed upon them by the Board of Trade.

As to 1. I consider that the lethal effect of the electric current was due to the large extent of contact made by the body of deceased with the charged rail, the considerable pressure, viz., a large portion of the weight of a man of nearly 13 stone, with which the contact was made, and the length of time, at least several minutes, during which the current was passing through his body.

With regard to 2, it must, of course, be borne in mind that this electrical tramway was one of the earliest constructions of the kind.

In my opinion the danger that has undoubtedly existed, has been largely due to the position of the charged rail at a height of about 18 inches from the ground.

Had this rail been placed at the ground level, it would have been far safer than it is at present; while if it had been raised to a height of not less than 8 feet from the ground, and greater width of opening allowed at gateways and road crossings, I think that, with proper regulation of the electric pressure, the working of the line would have been practically free from danger.

As at present arranged, the charged rail is easily touched by man or beast, and the effect of the shock is exceedingly likely to cause a fall across the rail, which, in itself, must probably produce physical injury, and also such a contact of the body with the rail, that the resulting electric current is large enough to cause death, unless assistance should be given at once.

With regard to 3, the tramway company allege that they have found a practical difficulty in complying with some of the regulations imposed upon them by the Board of Trade. There may be some grounds for this statement; but this difficulty should have been brought to the notice of the Board of Trade, with a view to the modification of these requirements, and even this excuse does not extend to all the failures on the part of the company to comply with regulations.

Recommendations.

I recommend that the tramway company should be required, under the provisions of Section 20 of the Act of 1880, to remove without delay the danger and annoyance to the public, which have been proved to result from their existing arrangements, by adopting one of the following (three) remedies, viz.:—

1. To remove the existing charged rail altogether, and adopt an overhead system, in which case the limit of electrical pressure might be reconsidered.

2. To raise the existing charged rail to a height of not less than 8 feet from the ground.

3. To effectively protect the existing charged rail as suggested by the complainants. This expedient, however, appears to me to be difficult to carry out, and in all respects the least desirable of the three.

The tramway company should also be required to exhibit, in a conspicuous position at their Bushmills station, an efficient and correctly indicating voltmeter connected to show the electrical pressure at this point of their line, and it is desirable that this should be arranged to make a continuous record, but in any case its indications must be clearly visible to the public.

Further, the tramway company should be called upon for a full explanation of the failure on their part to comply with the regulations made and imposed upon them by the Board of Trade.

In the meantime I think the company, having regard to the danger which has been shown to exist, should discontinue their use of electrical power until they have carried out the alterations decided upon, working their line entirely by steam power for the present.

I have, &c.,

P. Cardew, *Major.*

October 3rd, 1895.

ELECTRICITY AS A FACTOR IN THE PRACTICE OF MEDICINE.*

The two-days session of the National Society of Electro-therapeutists, held at Boston, recently, was a most interesting meeting as a whole. About 30 papers were presented by eminent physicians of the homœopathic school, some of them of particular interest only to medicos, but others well worth listening to or perusing by practical electricians. The order of business was classified and divided into bureaus, as follows:—"Bureau of General Electro-therapeutics," of which A. K. Crawford, M.D., of Chicago, was chairman; "Bureau of Diseases of the Nervous System;" "Bureau of Electro-surgery;" "Bureau of Electricity in Gynecology," and "Bureau of Diseases of the Eye, Ear and Throat."

The address of the president, William L. Jackson, M.D., who is recognised as one of the most advanced physicians of the Roxbury district, was an interesting and carefully written paper on the subject of the "Development of Electro-therapeutics and Its Relations to the Practice of Medicine." Dr. Jackson said:—

"When we stop to reflect upon the marvellous advance our civilisation has made in the last 20 years, we are struck especially by the development of that force which has long been familiar, but whose practical possibilities we had no conception of until recent years. During the years which have elapsed since the Centennial exposition, we have seen such wonderful development of this agent, which we call electricity, and in so many different directions, that we can only find a parallel in the marvellous magic of the Arabian Nights.

"Though electricity has long been used as a remedial measure, yet its marvellous attributes so early attracted large numbers of charlatans and impostors who made use of it to impose upon the credulous, that scientists, loth to be classed with humbugs, refrained from giving serious thought to its development. But recently great advances have been made for reasons which it may be worth our while to consider. The newly awakened interest of scientific men has led them to renewed investigation, and consequently we now understand better the nature of electricity. Instruments have been perfected, and are now commonly used by practical physicians in their daily work. There is a more uniform standard of measurement which enables specialists of different countries to compare results. Electricity, as a therapeutic agent is now used by physicians well versed in electro-physics and electro-physiology.

* *Western Electrician.*

"Much insight has been gained into the effects of electricity in disease by the careful and accurate reports of cases from which one can form a just estimate of appropriate methods and dosage to be used. Most prominent among those who have advanced the science in this respect is Apostoli, who gives us models of exact and complete histories.

"All who have devoted themselves to this subject in the last few years must recall their disappointment at the insufficient, obscure and unsatisfactory indications for treatment given even by books from the pens of brilliant men like Erb. de Watteville and Beard and Rockwell. Formerly we had only three or four text-books, but to-day there is at our command quite a library, mostly written within the last four or five years. Of especial advantage to the electro-therapeutist is the recent 'International System of Electro-therapeutics,' which contains the most advanced thought and methods of many leading authorities. All these factors combine to give electro-therapeutics a place in medicine unknown to it formerly, and to make it the duty of every physician to investigate the subject; for if disease can be cured more safely, surely and speedily by electricity than by other measures, he would be remiss in his great responsibility if he did not either make use of it himself, or advise its use by someone who is familiar with it.

"Just here I want to make emphatic the feeling of all electro-therapeutists, that this remedy is not a cure-all, that it has well marked limitations yet clearly defined indications for use. It has a sphere of usefulness all its own, which everyone must recognise. Because a patient has received no help from an application of electricity, it does not follow that his condition may not be benefited by it. Disease does not always yield at once to medicine, and why should we expect more of electricity? In many diseases a long course of treatment is required before any result is obtained. Take, for instance, a case of infantile paralysis, where the disease has been present for a long time before coming under treatment. In some of these cases most satisfactory results have been obtained by steadily following up the treatment for from one to two years. Too common a mistake with those who do not fully understand it, is to apply it in unsuitable cases, and at improper times, to the disappointment of the patient, and the discouragement of the physician, when this might have been prevented by more careful discrimination in the selection of the form of current, and a proper consideration of the dose.

"We have at our command a number of currents from which to select, and it requires considerable judgment, based on extensive experience, to decide whether the static insulation, breeze or sparks, the static induced current, the galvanic, the faradic, or the sinusoidal is the most suitable. Not only the kind of current, but also its direction, the pole and the dose, should be taken into consideration, and will require as much skill as the selection of a remedy.

"Electro-therapeutics is no longer the careless, haphazard practice it used to be, but is developing to the state of an exact science, having clearly marked indications for application to different diseases, and requiring nice discrimination. The power to successfully differentiate between methods of treatment can only come from close study of the physical effects of the current, and careful observation of its effects upon the human subject. The electro-therapeutist should receive as thorough training for practice as the surgeon, and he will get the best results who is enthusiastic enough to have mastered the subject, and not the half believer who occasionally dabbles in its use.

"That the profession is awakening to the advantages of electricity, Dr. King showed last year in his presidential address before this society, when he stated that the number of electro-therapeutic chairs in the different medical colleges has greatly increased. Moreover, the interest aroused among the fraternity has induced the formation of two flourishing electro-therapeutical societies in this country, as well as smaller local organisations.

"The underlying object of this society is to perfect our knowledge of electro-therapeutics by a mutual exchange of results and ideas. I venture to say that no one in the society claims a complete understanding of the subject, but all feel that they may receive valuable suggestions from even the youngest beginner. For this reason we welcome to our ranks all in good standing in the profession who desire to make use of electricity. Everyone can help the cause by keeping careful records of his cases, his method of administering the current, the doses employed, and finally the results obtained. If each member of the society would do this, and would report experiences, whether satisfactory or not, at our meetings, we should have the data for developing and advancing this science to the place where it belongs in the practice of medicine. It should be the aim of everyone of us to perfect our present knowledge, and to make careful investigations and experiments in new fields, not for our own advantage as individuals, but with the higher aim of benefiting suffering humanity.

"Already electricity has a wide sphere of usefulness. Even its physical properties, as heat and light, assist us. By means of its light we obtain a knowledge of internal organs and parts by which we are enabled to treat them far more satisfactorily than we could without its aid. It has been proved that the effect of the electric light on plants is to stimulate their growth and improve their condition. This being a fact, it is reasonable to suppose that it might have the same effect on animal life, and, indeed, recent experiments with the electric light bath upon the bodies of patients have shown this to be the case.

"Its power to produce heat is of especial advantage in surgery, where the cautery is used to destroy abnormal tissue. The electrolytic effect we use for the destruction of morbid growths, disfiguring marks on the face, and excessive growth of hair. By means of its cataphoric action, we can introduce medicines into the system. By its catalytic effects we may increase the circulation of a part, cause a change in the arrangement of the molecules, and even cause absorption of growths or inflammatory products. It is in diseases of the nervous system that it finds one of its most useful spheres of influence. Not only is it valuable in determining the site of disease, but it gives us most helpful aid in neuralgic affections and in paralysis. In neurasthenia we place especial reliance upon it in connection with general treatment. In gynecology, also, its power has been often proved. In spasmodic affections, in congested conditions, in exudations, in lack of tone of muscles of the pelvic organs, and even in tumours, good results may be expected in properly selected cases. In surgery the electrolytic and cauterising effects of the current can oftentimes be most beneficially made use of. Above all, it is one of the safest and best general tonics at our command.

"To sum up, electricity may be fairly claimed to be one of the most useful adjuvants in the practice of medicine. We do not intend to displace other methods of treatment which may be better in certain cases. The electro-therapeutist desires to walk hand in hand with his brothers in medicine, helping them in places where they are powerless, but leaving to the surgeon, the genealogist, the neurologist, each his legitimate work, and asking only for recognition in those cases which can be better treated by electricity than by any other method.

"In view of the wonderful development of this science during the last 20 years, who is so daring as to predict the limitations of this marvellous force in the treatment of disease? It requires no great skill at prophecy to foretell that in electricity medicine of the future will have its most helpful ally."

As has been intimated, the papers read covered a wide range of disease and physical disorder. Several were contributed from abroad, notably by the famous Dr. Apostoli, of Paris, and Dr. Cowl, of Berlin. Perhaps the paper of most general interest was that read by T. F. Livingstone, of New York, who attended the convention, and was in charge of the exhibit made by the Jerome Kidder Manufacturing Company, of New York. Mr. Livingstone's subject was "The Difficulties of Utilising Commercial Currents for Therapeutic Purposes from an Electrician's Standpoint." He said that the physician desires the use of the current for therapeutic work wholly, and consequently must consider quite fully the financial investment. In the first place, to be quite safe from danger, it would be necessary to show the voltage of the line, also to indicate whether it was direct or alternating current. For electrolytic and galvanic work in general the direct current is necessary, owing to the fact that strong polar effects must be manifest. With alternating currents the direct polarity is lost; to modify the current of the street current would require some resistance device or

rheostat to transform the current down in fixed proportions, these proportions to be further regulated by more direct devices. He asserted that an independent plant would give control of the current at all times, and a thorough regulation within the limits of safety, and that the cost per ampère of street circuit would be in excess of the cost to maintain the primary plant of first-class goods.

The H. W. Johns Manufacturing Company exhibited a device called "The Electrotherm," a flexible asbestos sheet or pad for use wherever the application of artificial heat is desired.

The Kennelly sinusoidal machine was exhibited by the Edison Manufacturing Company of New York. This machine was designed by A. E. Kennelly, after considerable experimental work, upon request of Dr. W. J. Morton, of New York, who had recently been in consultation with Dr. Apostoli, of Paris, and had witnessed his use of the sinusoidal current, and wished a machine that would produce a sine wave of a strength suitable for electro-therapeutic work. The current from the machine is of a most pleasing character, and there is an entire absence of that pricking, painful sensation, which generally accompanies the secondary current from even the most improved high tension coils. The outfit is equipped with the most perfect methods of separately regulating, by very fine gradations, the number of alternations, strength of exciting current and amount of secondary current to be employed on the patient.

The next annual meeting of the society will be held in New York City, where the newly elected president, Dr. A. P. Norton, and the secretary, Dr. F. M. Frazer, reside.

CORRESPONDENCE.

The Choice of Transformers.

Replying to "S. R. C.'s" letter in your issue of October 25th, I am sorry that "S. R. C." does not see his way clear to publish particulars of the transformer, which he states as capable of giving so high a performance. It is possible that the transformer in question may be of the open magnetic circuit type, if so the small iron losses would be easily accounted for. The drawbacks incidental to open magnetic circuit transformers are, however, so well known, that I need not mention them here.

Respecting the alteration of the transforming ratio from $\frac{2000}{100}$ to $\frac{1000}{100}$ in the 1,500-watt transformer alluded to by the writer in the ELECTRICAL REVIEW of September 20th, the primary turns being constant, the additional space required for the increased number of secondary turns would be one square inch of aperture in the iron shell. Indeed, in this particular case, the extra secondary turns could be got in without increasing the size of aperture at all, and, as a consequence, the length of magnetic circuit would not be increased.

The statement made by the writer in the above-mentioned article, to the effect that the iron loss would be diminished by reducing the primary voltage from 2,000 to 1,000, the primary turns and area remaining constant, was made to illustrate the meaning of the preceding formulæ and should not be taken to indicate that a transformer thus altered would give the best results commercially.

It is probable that a better transformer for practical purposes might be constructed by decreasing the primary turns and area of core, and increasing the secondary turns to a corresponding amount, involving a slightly increased induction in the iron core.

As a rule, the iron losses, at full load in closed magnetic circuit transformers, are much greater than the copper losses. In the case of the 1,500-watt transformer alluded to above, the iron losses at full load amounted to 79 watts while the copper losses in the two circuits amounted to 29 watts only.

It is for this reason that so much attention has been given to the reduction of the iron losses, and it is obvious from what has been already said that the use of low primary voltages renders the construction of transformers possessing the qualities of high efficiency and cheapness a comparatively easy matter.

George Adams.

October 29th, 1895.

Electric Lighting in Spain.

In reply to your correspondent's letter in your current issue, I am taking pains to verify the exact position of matters in the case of the Almodovar electric lighting, and have put myself in communication with the Alcalde of that town for that purpose; as also with my resident agent in that district.

If your correspondent will send me his address, I will acquaint him when I have the replies and place them in front of him, both in their original and translated forms.

The Editor, *El Ingeniero*

50, Fenchurch Street, E.C.

Unwarrantable Competition in Electrical Wiring.

Mr. Bergtheil's letter touches upon a subject that must be of interest to all wiring contractors at the present time. The subject is a difficult one for the Institution of Electrical Engineers to deal with, on account of its "trade" nature, but if it were in any way possible to find a remedy for the present state of affairs it would be worth a lot of trouble. The absurd differences that appear in electric light tenders seldom appear in other trades. In the *Contractor's Chronicle* for October 29th, there is a list of tenders for a large wiring contract, which starts at £2,685 and finishes at £1,124. In the same issue a list of tenders for building work, with 10 firms competing, starts at £1,324 and finishes at £1,158, seven out of ten prices being within £50 of each other. These contractors know what they are doing. In wiring work, nearly every large contract is undoubtedly taken at a price which must be considerably under cost, if the terms of the specification are adhered to. The pity of it is that so many good contracts are done at a loss, with no good to anybody. As you very truly remarked in a recent issue, "next to losing a contract, the worst thing is to get one." I am perfectly sure the contractors who take work at these prices regret it before they are through with the work. I agree with Mr. Bergtheil that the appointment of a committee to report on the matter would be advisable; in any case something should be done, if not by the Institution, by the contractors themselves, to prevent the trade, as regards his particular branch, absolutely being cut to nothing. Possibly it may work its own cure; but as long as new firms continue to rush in where others fear to tread, it will take a long time to do so.

Wm. Peto.

October 30th, 1895.

It is with pleasure that I notice in your last issue the letter of Mr. Bergtheil *re* above, and trust that it may be the means of bringing about a better state of things.

Considering the conditions of specifications, and stringent rules of certain fire offices, the prices that jobs are got at are much too low, and I for one would like to know *how it's done.*

The whole question seems to be of a complex nature, more particularly as a great proportion of the firms or individuals who go in for "throat cutting" are outside the influence of the Institution.

I most respectfully suggest that, if the matter were taken up by the Institution, a committee formed to investigate, and a typical case taken on which discussion might be invited, the time spent would be of *real* benefit to the profession.

Also, I propose, that members interested in this matter arrange a meeting at an early date, in order that some united action may be taken.

Chas. N. Russell, A.I.E.E.

October 29th, 1895.

A VEXED QUESTION.

FOR some time past public attention has been directed to a difference which has arisen between H.M. Government and the Government of Brazil, concerning the desolate and barren island of Trinidad, which lies in the South Atlantic some 600 miles to the eastward of the Brazilian Coast. It was at first difficult to understand how this sudden antagonism had

arisen, and why it should have aroused so much resentment in Brazil. Some light, however, is thrown on this subject by a letter recently published in the *Daily News*, signed "Anglo-Brazilian." In this letter, it is pointed out that the whole question turns on the success or non-success which the "cable ring" may have in the purchase of the cables at present uniting the various ports along the Brazilian Coast. The letter referred to is evidently written by one who is well-informed on the subject, but we must deprecate the introduction of the names of some of the directors of the Brazilian Submarine Telegraph Company into this affair, as tending to give a political aspect to what, after all, is only a purely commercial matter.

From an official source we gather that the actual position of affairs is as follows:—

The Brazilian Government has, in accordance with the right reserved under the concession granted in favour of the coast cables, which are owned by the Western Brazilian Telegraph Company, decided to purchase these cables. This action did not appear to suit the views of the Brazilian Submarine Telegraph Company, of which Sir John Pender is chairman, and the cables of which company unite Europe with Brazil. This company, therefore, offered to come to an agreement with the Brazilian Government, in virtue of which the Brazilian Submarine Telegraph Company would work the cables at present belonging to the Western Brazilian Telegraph Company, paying to the Government a certain percentage on the traffic, but reserving the option of at any time buying the Western Brazilian Telegraph Company's cables for the sum of £2,000,000. This offer, however, has not been accepted by the Brazilian Government, as, to quote from the official report recently published in Rio de Janeiro, "since 1882 the Government has been striving to escape from the monopoly of the Brazilian Submarine Telegraph Company."

It would also appear from this report that Sir John Pender complains of the reception accorded by the Brazilian Government to Mr. Depechez, an agent sent out specially by the Brazilian Submarine Telegraph Company to treat of the above matters; but, as is pointed out in the official report, "the agent of the Brazilian Submarine Telegraph Company included also in his proposal (of which, although not officially presented, this Government has a copy) matters relating to the Western and Brazilian Telegraph Company; this latter then declaring that it had not delegated its rights of dealing with the Brazilian Government to a third party, and protesting against any action taken in its name, unless through its own representative."

Under the above circumstances, it is not difficult to conceive that this agent met with a very formal reception.

In view of the particulars indicated above, and while negotiations are still pending with the Brazilian Government, it is most regrettable that the Trinidad *embroglio* should have arisen just at this time; as whatever may be the justice of our long-dormant claim to the possession of this island, now required as a cable station, the Brazilian Government can hardly fail to look on the sudden energy lately displayed as intended to force on the agreement suggested in such an irregular manner by Sir John Pender.

BUSINESS NOTICES, &c.

Change of Address.—Messrs. Roberts Bros., fuel economiser makers, have removed their economiser plant from Hadfield to Dukinfield, having purchased the extensive iron works formerly occupied by Messrs. Garforth. All communications should be addressed to "Dukinfield, near Manchester."

Messrs. E. P. Allam & Co. announce that owing to increase of business, they have taken larger offices and showrooms for electric light fittings at 14, Hatton Garden, E.C., to which address all communications must be directed in future.

Charged with Stealing Lamps.—George Fowler and James Murray were charged at the Mansion House the other day with stealing incandescent lamps belonging to the General Electric Company, Limited. The company have lately missed lamps from stock. They stand committed for trial.

Dynamo Brushes.—From the Boudreaux Dynamo Brush Company, we have received a sample of their new anti-friction gauze brush, which is made of the same metal alloy as their well-known foliated brush, and therefore possesses the same advantages, excepting that the duration is not quite so good, but it must be taken into account that the new brush is 25 per cent. cheaper than the foliated brushes. This is partly accounted for by the fact that the gauze pattern can be produced at less cost than the rolled metal pattern. We are informed that M. Boudreaux has sustained his patent rights against a number of infringers, whose goods, in large quantities, have been seized and confiscated.

Fire.—A fire occurred on 27th ult. at the engine house in which the electric light for Lord Bute's chapel at Cumnock is generated.

Interchangeable Expansion Seat.—From Messrs. J. Hopkinson & Co. we have received a pamphlet on "Improvements for the safer Working of Connected Steam Boilers," and a circular of their patent "interchangeable expansion" seat, which, it is claimed, not only provides for the unequal expansion and contraction that takes place betwixt the gun-metal valve seat and the cast-iron casing in high pressure steam valves, but also has the feature of being easily removed and replaced, or removed, and without dismounting the valve body. The experience Messrs. Hopkinson have had in valves for electric light stations leads them to believe their invention to be of great utility, because if valve seats are not free to expand when subjected to high-pressure steam, they soon become warped and loose, and the valves are then leaky and defective. Besides obviating the dangerous defects in valves consequent on unequal expansion of the seat ring and valve body, it has other advantages which are essential and important features in steam valves working on high pressure steam mains in electric light stations.

Liquidation Notice.—According to notice filed in the *London Gazette*, creditors of Hope-Jones Electric Organ Company, Limited, are required, on or before December 14th, to send their names and addresses, and particulars of their debts or claims to Mr. R. S. Blease, 8, Fenwick Chambers, Fenwick Street, Liverpool, the liquidator of the company.

Middlesbro' Exhibition.—At Stand No. 69 the British Aluminium Company, Limited, are showing an exhibit of aluminium in ingot and manufactured forms, aluminium alloys, aluminium bronze, and toughened aluminium, the latter now largely used for various castings in competition with brass, gun-metal, German silver, nickel-plated goods, &c., for various castings connected with engineering trades. Messrs. Crosier, Stephens & Co., 58, Collingwood Street, Newcastle-on-Tyne, the company's agents, have charge of the exhibits.

Phœnix Dynamo Manufacturing Company.—This company has secured orders for complete lighting of Denby Collieries, Derby, with Kennedy's single bobbin dynamo, also two electromotors, 15 and 30 horse-power, for Messrs. Robinson's Wheatbridge Mills, Chesterfield. Two 40-horse-power motors for Lord Masham's Colliery at Ackton Hall, Featherstone, have just been completed. A coal-cutting machine, which is in progress for a Dewsbury colliery, is being fitted with Kennedy's two-phase commutatorless motor. In alternators, this company has turned out two of Kennedy's ironclad machines for 10 volts and 2,000 ampères for applying electricity to special purposes in the wire-drawing trades. In photographic arc lamps they are also busy, having complete plants in hand for Messrs. Laird Bros., Birkenhead; Messrs. Turner & Drinkwater, Hull; and Messrs. Godhard, of Barnsley. The transmission of power by electricity in mines, mills, and other places, is a special line of business which is being pursued with success.

Ross-Hepworth Projection Arc Lamp.—Messrs. Ross and Co., of New Bond Street, W., are placing upon the market the Ross-Hepworth new projection arc lamp. The superiority of the electric light over limelight for optical lantern illumination has often

been demonstrated, and now that electric light mains are being laid in most of the public thoroughfares of the country, it is probable that limelight lanterns will have to step aside for the electric. The necessity of employing a lamp which, while being simple and por-

table, will also be reliable and efficient, is apparent. Mr. Cecil Hepworth, who has patented the arc lamp, which we illustrate herewith, and which will be seen to be hand-fed, claims that it will be found to meet the demands of lanternists. The carbons are supported by guide rods actuated by a pinion working between them. This pinion is connected with a tangent wheel, which by means of a worm wheel and handle projecting from the back of the lamp, imparts a slow feeding motion to the carbons. This handle will also bring the carbons together to strike the arc, by pushing the feeding handle forward, making the worm wheel act as a rack, giving a rapid rotary motion to the pinion, and so acting upon the guide rods as to bring the carbons together. The carbons are easily separated by means of a spiral spring on the feeding handle. This quick-striking mechanism is stated to be a peculiar feature of the lamp, as it enables the operator to set the carbons to the right distance before lighting up, and after a break in a performance it permits of immediately starting again with the carbons exactly in the same relative position as before. It also permits of the light being rapidly re-established should it from any cause become extinguished. The upper carbon holder is fitted with a milled head, by means of which the backward displacement of the positive carbon may be adjusted with great nicety, even while the lamp is burning. Upon the precision of this adjustment depends the clearness and uniformity of the disc of light upon the screen, and the ability to slightly regulate this during a performance is a distinct advantage. The lamp is fitted with a vertical rack-and-pinion motion for bringing the point of light into the optical centre and for keeping it there, should any irregularity in the rate of burning of the two carbons cause a slight displacement. The lamp is made to take carbons of 13 and 10 mm. diameters respectively, suitable for use with a current of from 10 to 15 ampères. If, however, it is desired to employ less current, brass adapting collars may be fitted into the carbon holders that smaller carbons may be used.

South Staffordshire Tramways Company v. Ebbsmith and Wain.—In the first Court of Appeal last Friday (present the Lord Chancellor, the Master of the Rolls, and Lords Justices Kay, Lopes, A. L. Smith and Rigby), application was made in the case of the South Staffordshire Tramways Company *v.* Ebbsmith and Wain, for leave to appeal from an order of Mr. Justice Hawkins, refusing to the plaintiffs' inspection of the bank books of the defendant Ebbsmith and of the Dickinson Tramways Appliances Company. The claim alleged as against Ebbsmith was that during the seven years in which he acted as solicitor for the plaintiff company, he sold at exorbitant prices worthless patents to the plaintiff company, without disclosing the fact that the Dickinson Tramway Appliances Company, which was nominally selling the patents, was, in fact, himself; that he sold land to the plaintiff company which it could not use under its articles of association; and that by means of shareholders created by himself, meetings of the company were influenced, and the plaintiffs claimed a return of secret profits alleged to have been made by the defendant while he was in a fiduciary position towards the company. Application was made to Mr. Justice Hawkins for leave to inspect the banking accounts of Ebbsmith and the Dickinson Company, to see what moneys had been paid to Ebbsmith and the defendant Wain, the chairman of the plaintiff company. This leave was refused, and permission was now asked to appeal. Their Lordships acceded to the application.

The "Quiver."—That very readable monthly periodical, the *Quiver*, published by Messrs. Cassell & Co., commences a new volume with this month's issue. There is a good assortment of interesting literature of a religious, philanthropic, and fictional character. The number before us contains a large variety of taking illustrations. The programme for the 1896 volume includes some very attractive items.

ELECTRIC LIGHTING NOTES.

Asylum Lighting.—The new Convalescent House at Murthley Asylum has been lighted by electricity by Messrs. Anderson and Munro, of Glasgow, according to specifications prepared by Mr. W. A. Bryson.

Bedford.—The following figures regarding the financial position of the Corporation's electric light undertaking has been furnished to the Press by the chairman of the Electric Lighting Committee:—

First annual instalment of principal	£480
One year's interest on £12,000	390
	£870

£870 per annum equals about ...	£16	14	7 per week.
Fuel, &c.	7	8	0 "
Wages, &c.	8	8	0 "
Salaries, &c.	3	0	0 "
	£35	10	7

The actual gross earnings for the week ending the 21st ult. amounted to £38 5s. A number of premises are waiting to be wired, and applications have been received from many ratepayers to have their houses connected; but no current can be supplied to new customers until the works of extension are completed.

Bolton.—The Corporation are now allowing a discount off their current bills to large consumers.

Bangor.—The Town Council has resolved, by twelve votes to nine, to apply for a provisional order, and retain Mr. Medhurst's services.

Bray.—The Town Commissioners are to apply for a provisional order to supply electricity for public and private purposes.

Burslem.—The Town Council has decided to light the Public Baths by electricity. The machinery at the baths will be used in connection with the installation.

Calcutta.—Last week we referred to a leading article in *Indian Engineering*, in which certain recommendations were offered regarding the proposed electric lighting of Calcutta. This was followed by a letter from a correspondent, who, referring to the cables suggested by the writer of the article, says similar cables may be seen in Bombay, "where electric installations are more numerous than in any other part of India, and where a number of very interesting specimens of cables, suitable for various systems of distribution, are on view. There one firm has laid underground cables which have given no trouble whatever for several years."

Cork.—The Electric Lighting Committee has brought up a second report, embodying a statement by a consulting engineer (Mr. T. W. Smith), in which he goes into details regarding system, &c. The Council is recommended to refuse to consent to the applications to be made by several companies for provisional orders, and to keep the powers in its own hands, a provisional order to be applied for for that purpose. We now learn that the order is to be applied for.

Dublin.—A correspondent of the *Irish Times* complains that 12 months ago he had his premises in Dame Street fitted ready for supply, but the current has not yet come.

Edinburgh.—There are now—although the system has only been in operation six months—30,000 lamps connected to the Corporation mains. This is even better than was anticipated by Prof. Kennedy in the report which he drew up in 1893. He then anticipated that within the first two years of running there would be from 20,000 to 25,000 8-C.P. lamps connected.

Fermoy.—The Commissioners have consulted with Mr. F. J. Warden-Stevens, electrical engineer, of London, regarding the practicability of lighting the town with electricity. He advises the use of water-power, thinks 1,000 private lights will be taken up, and that one 1,500 C.P. arc lamp will replace four gas. Schemes and tenders from companies are to be advertised for.

Glasgow.—The cover of a main box was blown off by an explosion which occurred at the corner of West George and Renfield Streets, on October 25th. A youth was slightly injured.

Guildford.—A Surrey paper says that sufficient capital has now been subscribed to float the Guildford Electricity Supply Company, and there is accordingly the prospect that Guildford will have the electric light very soon.

Hilderthorpe.—The *Yorkshire Herald* says that Hilderthorpe Lodge and Grounds are to be laid out as strawberry, tea, and sport gardens, both the buildings and the grounds being lighted by electricity and gas. It is also intended to lay down electric tramways throughout the estate from Hilderthorpe Lodge to the railway station and to other parts of the quay, and possibly to Flamborough.

Hospital Lighting.—The Metropolitan Asylums Board have been considering the question of lighting Brook Hospital and the Ambulance Station by electricity, regarding which Prof. Kennedy has reported. The cost of wiring the Ambulance Station is estimated at £300, but it is to be included as a distinct item in the contract for lighting the Brook Hospital. In accordance with the recommendation of Prof. Kennedy, the board has resolved to invite the following firms to tender for the engines, dynamos, switchboards, and batteries:—Siemens Bros., Crompton & Co., Johnson & Phillips, J. H. Holmes & Co., Thos. Parker, Limited, British Thomson-Houston, Limited, W. H. Allen, Son and Co., Mather & Platt, Davey, Paxman and Co., Robey & Co., Limited, Marshall & Sons, Limited, The Electric Construction Company. The wiring of the buildings is being advertised for public tender.

Kettering.—The Electric Light Committee has submitted a report regarding the cost of a proposed electric lighting installation. The report states that 2,500 8-C.P. private lights would be taken up, and that 20 arc or incandescent lights could do the street lighting. Total cost estimated at £9,500; annual expenditure £1,050. The committee recommend that application be made for a provisional order. The Council has deferred consideration to the next meeting.

London County Council and Electric Lighting.—The Finance Committee reported at a meeting of the County Council, on Tuesday, the receipt of Treasury sanction to the period of 53 years within which the Islington Vestry have to repay a loan of £5,150 for the purchase of land for extending the electric light station. The Establishment Committee reported that in consequence of the large amount of work devolving upon the electric lighting staff of the engineer's department, especially in connection with the inspection of electric light installations at theatres and music halls, &c., additional assistance is required in that department. The Committee accordingly recommended, and the Council adopted, the suggestion that a temporary assistant should be engaged for a period of three months, at a salary of £3 3s. per week.

Llanelly.—The Llanelly Borough Council has made an offer to Messrs. J. C. Howell & Co. to sell its provisional order for the lighting of the town by electricity for £200.

Oswestry.—The question of lighting the Guildhall by electricity is before the Town Council.

Oxford.—The Oxford Electric Company have had to order, and are now erecting, another 200-H.P. generating plant at Osney. They have also considerably increased their storage capacity in the centre of the city, as well as installed an additional motor-generator in the sub-station at Brasenose College. These extensive additions have been rendered necessary by the great increase in the company's business during the past 12 months. This time last year 11,000 lamps were connected. At the present moment there are now connected 14,000 lamps, with several large customers in prospect, noticeably the new Municipal Buildings, Somerville Hall, the new Dragon Schools, and the public street lighting. During the year, considerable extensions of the company's mains have been made. Motors of various powers have been placed in several business establishments.

Queenstown.—The new Commissioners, after considering the question of gas *v.* electricity, have decided to apply for a provisional order for electric lighting, and have accepted the offer of Messrs. Hanley & Shanks, electrical engineers, to light the town from the club to the post office with four arc lamps for 14 days, for about £25, just by way of experiment.

Southampton.—The Harbour Board are taking steps to provide their own electric lighting installation, thinking they can manage it cheaper than the present arrangement with the Electric Light and Power Company will allow. The surveyor has prepared plans for a supply station, and the electrical engineer has submitted a report and tracing. He recommends four gas engines (two for lighting and two for power), and a battery for lighting when the engines are not running. The estimated cost is £5,500.

Spain.—Work is well in hand on the construction of a central station at Jerez de los Caballeros (Badajoz province). One is also rapidly approaching completion in the town of Quintanar de la Orden (Toledo). Tenders have just been invited for the concession for the electric lighting of the town of Soria by means of 200 16-C.P. lamps.

Stapleton.—After discussing the question of public lighting, the District Council has appointed a committee to consider the question of substituting the electric light for gas.

Stafford.—A Local Government Board Inquiry was held on 25th ult. regarding the Corporation's application to borrow £5,000 for electric lighting extensions, the contracts for the necessary plant, &c., being already placed.

ELECTRIC TRACTION AND MOTIVE POWER NOTES.

Birmingham Central Tramways.—It is stated that this company is in negotiation with the City Council with the view to the trial of an overhead system of electric traction on their Nechells route.

Cable v. Electric Tramways.—The Newcastle City Council, on 28th ult., had the question of cable *v.* electric traction before it, and after a protracted discussion, decided in favour of cable by 39 votes to 11. They have now sanctioned a lease for 21 years of the cable system for the town.

Derby-Ashbourne Light Electric Railway.—The chairman of the provisional committee for the promotion of the Light (Electric) Railway from Derby to Ashbourne, issued on Monday to the promoters a circular, in the course of which it is stated that "the scheme has been enthusiastically received by the Ashbourne farmers and several gentlemen, thinking that it would benefit the agricultural community, and promote local interests generally, have promised to subscribe towards the expenses of obtaining Parliamentary powers, it being understood that in the event of the failure of the scheme, any money beyond what is required for actual out of pocket expenses shall be returned to the subscribers rateably; but if the Bill is passed into law, and a company incorporated thereunder, £1 shares in such company shall be allotted to each subscriber for every £1 subscribed. Further support, however, is needed to justify the committee in proceeding with the application for the Bill."

Electric Road Carriages.—Addressing the shareholders of the Anglo-French (Colonial) Mining Company on Monday, the chairman said they had purchased an interest in the Ward Electric Car Company, and they thought it would result in a very handsome profit to the company. "There is no doubt that electricity is going to be the motor of the future. I think the time is not far distant when we shall see the streets of London without horses. The drawback to electric cars in the past has been, I believe, the weight of the cars; but Mr. Ward has overcome this difficulty, and I am told he is prepared to put on the streets of London 'buses and carriages that will run even lighter than the ordinary horse-cars. I believe our shareholders will have the pleasure of seeing two landaus which Mr. Ward is having fitted up to run round and show the people what he can do in this respect."

Electric Traction in Italy.—The Unione Italiane Tramways Elettrichi is the name of a company which has just been formed in Genoa with a capital of £120,000.

Electric Traction in Austria and Hungary.—Plans are being prepared for a projected electric tramway between Veszprim and Keszthely. A concession has been granted for an electric tramway between Olah-Toplicza and Borszekfurdo. Work is about to be commenced on the construction of a line of electric tramway between Szabadka and Palics. Messrs. Ganz & Co., of Buda Pesth, have submitted plans for an electric tramway to connect the town of Miskolcz with the Miskolcz Ironworks. An electric tramway has just been completed and put in operation between Teplitz and Eichwald. The line is about 9 kilometres long.

Electric Traction in France.—The construction of an electric local railway between Besançon and Levier has just been decided upon. The line will be on the overhead conductor system, and have a gauge of 1 metre, while its length will be 60 kilometres. A company has lately been formed to construct and operate an electric tramway at Saint Romain (Seine Inférieure), connecting the town with the railway station. An electric tramway is also about to be constructed between St. Symphorien-sur-Coise and Viricel-Chazelles (Loire).

Isle of Man Tramways.—Permission has been granted for the construction of an electric or mechanical tramway or lift from the bridge connecting Douglas with Douglas Head (now in course of construction) to the commencement of the lines of the Douglas Southern Electric Tramways, Limited. The tramway or lift will run in connection with the Douglas Southern lines, thereby making a practically continuous tramway from Douglas to Port Soderick.

The Council last week considered the Bill to authorise the Isle of Man Tramways and Electric Power Company, Limited, to construct a street railway to Upper Douglas, and to carry out the terms of a certain agreement made between the company and the Douglas Commissioners. After considering the general proposals of the Bill, the discussion was adjourned.

Storage Batteries for Traction in the States.—From a trans-Atlantic exchange we learn that a new company, to be known as the Metropolitan Electrical Development Company, has been incorporated in Jersey City with a capital of a million dollars, for the purpose of developing storage batteries for traction purposes. It is expected that the company will shortly put an experimental car on the St. Nicholas Avenue Road, New York City. Another move being made in storage battery traction is by the Fourth Avenue Street Railway of New York, who will soon have several storage battery cars on their line equipped with chloride batteries. For the purposes of the trial, cars of the standard trolley type, with 18 feet bodies, have been specially made; trucks of the standard make also are used, a change in the position of the brake-rods being the only one necessary to be made. The motors are wound for 120 volts, and the controller to be used is similar to that on ordinary trolley cars. The cells will be placed in wooden trays and hung underneath the car bodies. Each tray will hold 60 cells, capable of operating the car 60 miles on one charge. In our issue of September 6th, we referred to the cars to be used by the New York and Harlem Railway Company, which would have the cells suspended from the truck. Those which are to be used by the Fourth Avenue Street Railway Company will be similarly carried, and the cars will possess the same facilities for changing the cells as in the other instance quoted. It is the company's intention, however, to have later on battery pits in the streets, to save the trouble of running into the car house. By suspending the batteries from the truck, instead of placing them in the body of the car, it is possible to operate open cars by accumulators, which hitherto has been considered impracticable on account of lack of space beneath the seats. Moreover, as the batteries are outside of the car, it is thought that there will be absence of any unpleasant odour from sulphuric acid.

Tramcar Propulsion for Glasgow.—Sir William Arrol has been interviewed by the *Glasgow Mail* with respect to the mechanical propulsion of tramway cars, which question has been before the Glasgow Corporation for some time. Sir William's opinions occupy nearly a column, but we will give the gist of them in a few words. Cable traction:—Absolutely unsuitable for Glasgow. Electric traction—overhead system:—All right for quiet straight runs in a village or suburbs, but he does not approve of it for a city like Glasgow. Mr. Johnston's oil motor system:—We referred to an excellent performance of this motor in a recent issue, but in spite of that performance Sir William, having seen the motor at work, considers it the best motor he has yet seen for tramway purposes. He is of opinion that only one system should be adopted for the whole of the city.

The Central London Railway.—The work of constructing subways beneath the space opposite the Mansion House in connection with the new underground railway will shortly be commenced. Arrangements are being made for sinking a shaft at this point, and in order that its construction may not interfere unduly with the pedestrian and vehicular traffic, the work will be executed between the hours of 8 p.m. and 8 a.m.

Tunbridge Wells and Electric Tramways.—The move in electric traction has now reached Tunbridge Wells. A meeting of the Ratepayers' Association the other day discussed the advisability of adopting a system of electric tramways for the town, the question of a suitable system giving rise to a good deal of discussion. The matter seemed to be favourably considered, but no resolution was passed.

TELEGRAPH AND TELEPHONE NOTES.

African Telegraphs.—We hear that the Beira and Salisbury telegraph line on the route is now all but completed.

Coast Communication.—The Marine Committee of the Mersey Docks and Harbour Board report that the electrical communication between Formby lightship and the shore has now been completed.

The Coastguard Station on the East Cliff, Ramsgate, has been telephonically connected with the Harbour Master's Office and House and the Watch House on the East Pier Head, thus enabling information of disasters on the Goodwins to be speedily communicated.

Damaging Insulators.—There has been a number of cases in the provincial Courts of lads being charged, and fined, for throwing stones at telegraph poles and insulators. In some districts, these foolish tricks have been carried to an incredible extent. It is to be hoped such cases will be dealt with as they deserve, so that an end may be put to the nuisance.

Indo-Chinese Telegraphs.—An Indian contemporary says that the important telegraph lines completed during the year comprise the Srinagar-Astor connection, and also connections between Bhamo and Momien, the frontier stations of India and China, thus establishing direct overland telegraphic communication between the two empires.

Perfide Albion.—The French Press has lately devoted a considerable amount of space to the subject of submarine cables. These articles are more noticeable for the splenetic spirit in which they are written than for their accuracy. We translate the following from *Le Matin* of Friday last:—"The submarine cables belonging to England, on which other countries have to depend, always break at an opportune moment. It will be remembered that during troubles at Bangkok there were extraordinary interruptions on the Eastern Telegraph lines; so much was this the case that it might have been said that at that moment electricity had become one of the most dangerous opponents to our diplomacy. When the Sultan of Morocco died, England alone was advised of this. The Havas Agency published in Madrid a message which contained more than one protest. Finally, at the moment when France awaited, with anxiety, news from our expeditionary forces marching on Tananarivo, we suddenly learnt that the cable had broken. It was London which was kind enough to provide us with news from Tananarivo. There the news of success had been known for three days, while we still awaited an official announcement. Thus we have to rely on the good pleasure of England even concerning the Madagascar cable, laid a few months ago." A little further on in their article, the writer says, referring to the Majunga-Mozambique cable:—"But how would this line be put in communication? *It seemed natural that this would be done via Tunis*, which was already served by a French cable. Still, the Government proposed to graft our new branch line on to the English network" (of cables). The italics above are our own; a glance at the map would have shown the writer that the *direct* distance from Tunis to Mozambique "as the crow flies," across the Sahara, Nile Valley, *via* Victoria, Nyanza, Unyanyembe, &c., is not far short of 4,000 miles. With this information as a guide, doubtless *Le Matin* can give its public further details. The same journal also complains that it has been necessary to apply to England for various other cables. It will be remembered that even in the case of the Mozambique - Madagascar cable, the French manufacturers who actually made it received a price about 70 per cent. higher than that for which an English company offered to do the work. Under these conditions *Le Matin* surely has no cause for complaint against the French Government!

The Pacific Cable Scheme.—At the invitation of Sir Charles Tupper, a meeting was held at the Canadian Office, on Tuesday, to discuss the Pacific cable scheme. In addition to the High Commissioner for Canada, there were present the representatives of the Australasian and South African Colonies. The instructions sent by the various Colonial Governments to their representatives were discussed in view of the probable forthcoming conference with the Secretary of State. Reuter's Agency is informed that the colonies, being quite prepared to substantially support the scheme, are desirous that the question should no longer remain in abeyance. The question of a fast trans-Atlantic service will not be discussed for the moment, the negotiations bearing more directly upon the cable scheme proper. It is added that the reported granting of a concession for an exclusive American cable between the United States and the Hawaiian Group will probably necessitate the landing of the British cable on another Pacific island at a higher cost. The date of the conference with Mr. Chamberlain will not be fixed until the return to town of the Secretary of State.

Telephonic Communication between Belgium and Holland.—The *Daily Chronicle* Brussels correspondent telegraphs:—Telephonic communication has now been established between Belgium and Holland. The service is worked on a strictly democratic basis, the maximum charge for a five minutes' conversation being only 2s. 6d., while a monthly subscription of about £3 10s. entitles the subscriber to a daily conversation at fixed hours.

The Island of Trinidad.—The *Daily News* of 24th ult. published a lengthy letter from "Anglo-Brazilian," and a leading article regarding the question of Brazil and the Island of Trinidad. The writers connect the Brazilian Submarine Telegraph Company and the associated cable "ring" with the matter, and accuse them of having managed, "with considerable ingenuity, to embroil our Government with a friendly state, and to raise a series of complicated questions which will take much patience and diplomacy to settle." Further reference to this matter will be found on page 545, also in the report of the Brazilian Submarine Co.'s meeting in our "City Notes."

CONTRACTS OPEN AND CLOSED.

OPEN.

Bedford.—November 1st. The officials of St. Paul's Wesleyan Chapel are inviting tenders for electric lighting and other improvements. Particulars from the caretaker.

Belgium.—November 8th. The Municipal Authorities of Tongres have extended the date for the receipt of tenders for the concession for the electric lighting of the town from the 10th inst. until November 8th. Tenders to be sent to the Conseil Municipale, Hotel de Ville, Tongres.

Blackburn.—November 30th. The Corporation invite tenders for alternators, transformers, switchboards, &c. Details to be found in our "Official Notices."

Christiania.—November 5th. The Secretary of State for Foreign Affairs has received information to the effect that the electrical works at Christiania require tenders for coal, either 2,000 tons best coal or 1,000 tons each of best gas coal and smokeless coal. Dates and conditions of delivery may be seen at the Commercial Department of the Foreign Office between the hours of 11 and 6, and further details can be obtained at the office of the electrical works in Christiania, where tenders must be delivered before November 5th.

Germany.—November 15th. Tenders are being invited by the State Railway Telegraph Department at Saarbrücken, Germany, for the supply of 1,500 telegraph poles. Tenders to above address.

London.—November 18th. From our Official Notices will be gathered information regarding tenders invited by the Metropolitan Asylums Board for wiring and other electric light work at the Brook Hospital and Ambulance Station, Shooter's Hill. This matter is also referred to under "Electric Lighting Notes."

Madrid.—November 15th. The Director of Public Works is inviting tenders for the concessions of the construction and working of a tramway from Madrid to Colmevar Viejo, with branches to Chamartin and Rosa. Security 12,505 pesetas. Particulars at the Direccion General de Obras Publicas (Ministerio de Fomento), Madrid.

Nottingham.—November 9th. Tenders are invited for supplying a Lancashire steel boiler, 26 feet long and 7 feet diameter, for the Corporation. Particulars of Mr. Arthur Brown, M.I.C.E., borough engineer, Guildhall, Nottingham.

Rangoon.—November 4th. The Municipal Committee is inviting tenders for electric lighting. Particulars to be obtained from Messrs. Ogilvy, Gillanders & Co., 67, Cornhill, E.C.

Vienna.—November 14th. The Municipality of Vienna asks for tenders and plans for the construction and working of electric railways in and around the city. The notice may be seen at the Commercial Department of the Foreign Office.

CLOSED.

Ayr.—The tenders sent in for wiring and fitting the municipal buildings for electric lighting were as follows:—

	Scottish Elec. Eng. Co.	M'Leod & Co.	W. G. Higgs & Co.
	£ s. d.	£ s. d.	£ s. d.
Wiring to points, with fittings, as per schedule	1 2 6	0 0 0	1 0 10
8, 16, or 32 C.P. lamps	0 0 0	0 18 6	0 0 0
Extra lamps	1 2 6	0 15 0	0 16 0
Do. on new premises	1 2 6	0 18 6	0 16 0
Wiring only	0 0 0	0 0 0	0 12 0
Arc lamps	8 10 0	8 5 0	7 0 0

As already stated, Messrs. Higgs tender was accepted for the wiring. Estimates are to be invited for arc lamps.

Belfast.—The Corporation has accepted the tender of the Acme Gas Engine Company to supply and erect two combined gas engines and dynamos of 150 H.P. each, direct coupled, for the central station.

Brussels.—The following list is given in the *Contract Journal* of the tenders submitted for the supply of cables and copper wire (bare and covered), for the telegraphic service, specification No. 24. For 1,300 to 2,000 metres of house wires (two conductors), 1,200 to 1,600 metres ditto (six ditto), 300 to 400 metres of river cable (two ditto), 700 to 900 metres ditto (four ditto), 1,500 to 1,800 metres of submarine cable (six ditto):—

	Francs.
L. Hen et Cie., Schaerbeck	13,019
Felten et Guilleaume, Mulheim	13,147
G. Boty, Brussels	15,055
Société Industrielle des Téléphones, Paris	15,333
S. Hirschmann, Berlin	15,501
Clouth, Cologne	16,978

For 675 to 900 kilogrammes of annealed copper wire, diameter 1·2 millimetre; 200 to 300 kilogrammes ditto, diameter 1·6 millimetre; 300 to 450 kilogrammes ditto, diameter 2 millimetres; 155,000 to 200,000 metres of gutta-percha-covered copper wire cased with white and brown cotton; 87,000 to 110,000 metres ditto cased with asphalted cotton; 30,000 to 55,000 metres ditto, with a layer of coloured incombustible cotton; and 2,500 to 3,500 metres of flexible two-wire conductors:—

	Francs.
L. Hen et Cie.	23,267
Even, Liége	23,675
Felten et Guilleaume	25,843
Clouth	33,681
Société Industrielle des Téléphones	35,750
S. Hirschmann	38,553

Croydon.—The following tenders were sent in for wiring and fitting the new Town Hall, courts, and free library for electric lighting for the Council, Mr. Charles Henman being the architect:—

	£	s.	d.
H. Binko & Co., 34, Leadenhall Street, E.C.	1,124	15	0
Wenham & Waters, Paragon Works, Croydon (accepted)	1,253	0	0
S. J. Waring & Co., Limited, 181, Oxford Street, W.	1,325	10	0
Spagnoletti & Crooks, Goldhawk Works, Shepherd's Bush	1,450	0	0
Vaughan & Brown, 16, Kirby Street, E.C.	1,455	0	0
Roger Dawson, Limited, 63, Berners Street, W.	1,467	10	0
Paterson & Cooper, 3, Princes Mansions, Victoria Street	1,530	10	0
Strode & Co., St. Paul's Churchyard, E.C.	1,537	0	0
Lund Brother & Co., 123, Oxford Street, W.	1,548	0	0
New & Mayne, Palace Chambers, S.W.	1,590	0	0
Edmundsons, Limited, 19, Great George Street, S.W.	1,643	0	0
Hollingum & Saword, 31, Holborn Viaduct, E.C.	1,675	0	0
Hy. F. Joel & Co., 31, Wilson Street, Finsbury, E.C.	1,688	17	0
A. C. Hands, 194, Upper Thames Street, E.C.	1,743	5	0
Page & Miles, 60 Western Road, Brighton			
Fowler Lancaster & Co., Albert Works, Birmingham	1,775	0	0
Graham & Biddle, 461, Oxford Street, W.	1,776	12	10
Peto & Radford, Hatton Garden Electric Works, E.C.	1,824	0	0
Laing, Wharton & Down, 17, Gracechurch Street, E.C.	1,861	1	9
Rashleigh Phipps & Co., 102, Oxford Street, W.	1,880	0	0
Winfields, Limited, Cambridge Street Works, Birmingham	1,980	0	0
Pettit & Hards, 2, Duke Street, Adelphi, W.C.	2,070	0	0
Smeeton & Page, 63, Queen Victoria Street, E.C.	2,250	0	0
J. S. Cunnington & Co., 5, John Street, Adelphi, W.C.	2,439	0	0
Hirst & Co., St. Michael's Road, Croydon	2,685	0	0

Glasgow.—The following tenders were sent in for the electric wiring and fitting of the new Family Home, St. Andrew Street, for the City Improvement Trustees, Mr. W. Arnot being the engineer:—

	£	s.	d.
R. Miller, Glasgow (accepted subject to approval by Town Council)	312	0	0
W. Dixon & Co.	345	0	0
McLeod & Co.	370	0	0
Smillie & Co.	380	0	0
W. Bryden & Son	415	0	0
Claud Hamilton, Limited	425	0	0
Anderson & Munro	526	0	0
D. Stewart & Co.	540	0	0

Motherwell.—The lowest tender sent in for electrically lighting the hospital for the Lanark District Council was that of Messrs. Wm. Harvey & Co. of Glasgow, the amount being £2,082 odd. On the recommendation of Prof. Jamieson the tender has been accepted.

NOTES.

Club Lighting.—The buildings in course of erection at Stroud for the Conservative and Unionist Club, are to be fitted throughout with electric light. The installation will consist of a 10 H.P. gas engine, dynamo, 54 accumulator cells, and an equivalent of about 220 8-candle-power incandescent and two arc lamps, with fittings, &c. The contract has been placed in the hands of Mr. A. G. Sanders, of Cheltenham.

The Milver Battery.—On September 9th Mr. Arthur Levetus, writing to us, stated (see our "Correspondence" columns for September 13th) that the Milver Portable Electric Battery Syndicate, Limited, would shortly have a public demonstration of its uses. Two months have passed, and yet we have not received notice that the opportunity has arrived for us to give the matter our fullest investigation. So far, it does not seem to have got any further than making the "new epoch in the influence of motive power on the life and work of the world."

Gas Engines and the New York Elevated Railroad.—An announcement recently made in the New York daily press that Mr. Westinghouse had recommended a new type of gas engine, manufactured by the Fuel Gas and Manufacturing Company, to drive the dynamos for the electric central stations which are contemplated in connection with the electrical equipment of the "L" road, seems to have aroused considerable interest. This so-called new type of gas engine referred to by Mr. Westinghouse was fully illustrated and described in the New York *Electrical Engineer* of June 28th, 1893, in an article entitled "The Pittsburg Gas Engine." The engine is the design by Mr. Albert Schmid, and ought to add much to economy in fuel as compared with most steam operated stations.

From the Coal Pile to the Meter.—In the paper on this subject presented to the recent meetings of the Canadian Electrical Association, Mr. James Milne presented an interesting series of curves calculated from different sources showing the efficiency of the various parts of a generating plant. We gave the curves in our last issue, but the results, expressed in percentages, are given in tabular form below:—

Power for running generators	100
Power available at switchboard	92
Power available at meter	78·20

Efficiency of the electrical apparatus, including outside circuit = 78½ per cent.

Engine	100
Available for generating current	83·3
Available at switchboard	75·72
Available at meter	64·35

The commercial efficiency from engine to meter is 64·35 per cent.

Boiler equivalent	100
Indicated H.P. at engines	7·04
Available for generating current	5·79
Available at switchboard	5·33
Available at meter	4·53

The efficiency, therefore, from the boilers to the meter is 4·53 per cent.

Coal pile equivalent	100
Available at stop valves of boiler	62·47
Indicated H.P. at engine	4·4
Available for generating current	3·62
Available at switchboard	3·33
Available at meter	2·83

We see, therefore, that the electrical end shows up exceedingly well. For every 100 H.P. at the engine, 82·3 are utilised for generating current, and 75·77 of these are sent out to the line, which, although it could be improved on, leaves very little to be gained by any new invention or alteration that may hereafter be made.

Electric Light Matters at Cardiff.—Whenever there is anything fresh in electric lighting matters at Cardiff, there is one anxious ratepayer always to the front captiously criticising the Corporation management of the installation. At a Local Government Board inquiry held last week into the application of the Corporation to borrow £12,885 for electric lighting purposes, part for extensions and part to pay for the excess spent on the original installation, Mr. Sydney F. Walker put in an appearance, and, according to the report of the proceedings published in the local press, cross-examined Mr. Harpur and Mr. W. H. Massey at some length, and accused the Corporation of carrying out the work wastefully and with their eyes open. He made certain statements which both the borough engineer and the consulting engineer flatly contradicted. The reason for his attitude in regard to the electric lighting work at Cardiff, which has furnished the local papers with a good deal of copy from time to time, may be gathered from his statement that "if he had been able to gain the information during the last three years that he had procured that morning, the borough engineer and Mr. Massey would not have been troubled with him nearly so much." Mr. Massey said Mr. Walker might have had every information if he had applied properly, as other engineers had done. Later on he stated he had been refused permission to the central station, but it transpired that he had not made proper application.

The Dublin Electric Tramways.—It was intended to make a trial run of the electric cars on the electric tram line from Haddington Road to Kingstown on 28th ult., and some popular curiosity was aroused as to the result. The directors of the company, however, after examining the state of the road, decided to postpone the trial until the entire works over the whole line have been completed, which will probably be in about two months hence.

The Institution of Junior Engineers.—Mr. Archibald Denny, M.I.N.A., of Dumbarton, who has accepted the Presidency of the Institution of Junior Engineers, in succession to Mr. Alexander Siemens, M.I.C.E., will deliver his Presidental Address this evening at the Westminster Palace Hotel, Prof. A. B. W. Kennedy, LL.D., past-President, presiding.

Results of Tests made in Engineering Laboratories.—A recent test of the Wheeler condenser was made on an apparatus rated at 50 H.P., the steam surface being measured on the outside of the tubes, touching the steam and the water surface upon the inside. The steam condensed and the water used were separately weighed. Excepting that the greatest weight of steam condensed is an accompaniment of the three instances of the greatest amount of water used, there is nothing particular to be drawn from these results. These three tests had the highest steam pressures; but other results do not seem to agree, and nothing can be decided from inspection of the figures, apart from what might possibly be made plain by graphic methods. The Mack injector shows from 8·2 of water to each 1 of steam to 14·1 of steam, the best results appearing to accompany small steam pressure, and similarly low delivery pressure. Of the boiler tests there is little to say, the coal consumption per foot of grate surface being only light, and not very useful as a comparison in practice. Low rates of combustion accompany the highest evaporative effects, as usually observed; but conditions widely different are not always accompanied by corresponding other changes, the evaporation per square foot of heating surface of a Babcock boiler, varying from 2 to 2¾ lbs., for rates of coal consumed per square foot of grate of 10 lbs. and upwards to 14 lbs., the best result being that obtained with 12·88 lbs. of coal per square foot, namely, 2·77 lbs. evaporation per square foot of heating surface. A Douglas hydraulic ram shows an efficiency as low as 33·3 per cent. for a lower delivery pressure of 19 lbs., and as high as 64·5 per cent. for a delivery pressure of 13·2 lbs., and even of 67·9 per cent. for the same pressure; but its average efficiency is about 50 per cent., against about 20 lbs. pressure, the head of supply being 12 feet 4 inches.

Tramcar Traction.—In a letter to the *Newcastle Daily Leader*, Mr. A. L. Steavenson says:—

> Will those members of the Council who think "the cable system of haulage is already obsolete," select a wet, slushy night, when the ground is covered with snow, and get into one of the present trams (the fuller it is the better), take away the horses, and come down Westgate Hill with the brakes of the vehicle only to regulate the speed of their descent? Because that is the position in which they will put matters if ever they adopt electricity.

Has the writer never heard of another method for regulating the downhill speed of electric cars, *i.e.*, reversing the motors?

Electrical Engineer Wanted.—The Ealing Urban District Council are inviting applications for the appointment of electrical engineer to superintend the whole of their electric lighting undertaking. Applications to be in by 3 p.m. on November 6th.

Horseless Carriages.—In further correspondence on this subject in the *Daily Telegraph*, Sir David Salomons says he has been deluged with letters from all parts, proving "conclusively that a widespread interest in this mode of locomotion exists" throughout the country. Sir David says he is willing to receive communications from all desirous of joining an association to deal with self-propelled traffic, and asks that all letters be marked "Automobile" in the corner of the envelope. Later on a meeting will be held in London to consider what steps should be taken in the matter.

Discovery of Roman Relics in the City.—We give the following on the authority of the *Sun*:—

> A discovery, which is exciting great interest among archæologists, has just been made in the City in connection with the construction of the new electric railway between Waterloo and the Mansion House. At Queen Victoria Street the workmen have come unexpectedly upon an interesting number of Roman remains, consisting of bricks and tiles, mosaic pavement, &c., evidently associated with the Roman occupation of Great Britain. The remains are being carefully collected.

The Electric Lighting of Tramcars.—A few weeks ago we referred to experiments being made by the North Metropolitan Tramways Company on the Aldgate and Stratford section. We now learn that these experiments are being conducted with a view to ascertaining whether there is a battery in the market that will stand the work, and do it at anything like a reasonable figure, compared with the present oil lighting. We are informed that, so far, the result is far from satisfactory.

Provision Against Arcing.—The insurance companies of Chicago have made some experiments with a view to fixing the distances to be prescribed between the various parts of the interrupters, circuit-breakers, &c., with the object of avoiding the production and the persistence of a voltaic arc formed during the interruption of the current, or developed spontaneously, owing to there being too little distance between two points brought to a difference of potential of 500 volts. This distance is, of course, a function of the intensity of the current. In the accompanying table, which sums up the results of these experiments, the intensities of the currents are expressed in ampères, and the distances in millimetres.

Intensity of current in ampères.	Safe distance in millimetres.
10	25
20	50
30	69
40	82
50	88
60	94
70	101
80	104
90	110
100	113

Corresponding to the Royal Society.—A contemporary, in reporting a speech of Mr. Bernard Drake, represents him as comparing the Franklin Institute of America to our Royal Society. A pretty compliment this to the men who are privileged to add to their names the coveted letters F.R.S.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

Buenos Ayres Electric Light Company, Limited (16,057).—This company's annual return has just been filed. The capital is £100,000, in 9,986 £10 ordinary and 70 £2 founders' shares, and the £2 shares have been taken up, but no calls have been made.

Bickle & Co., Limited (36,429).—This company's annual return was filed on October 5th. 2,030 shares have been taken up out of a capital of £50,000, and 1,000 are considered as paid. £10 per share has been called on the others, and £10,223 has been paid, with £77 still due.

Aurora Electric Lighting and Distribution Company, Limited (34,109).—This company's annual return was filed on October 14th, when 5,935 shares were taken up out of a capital of £25,000, in £1 shares; 5,000 have been considered as paid, and the full amount has been called and paid on the rest.

Acetylene Illuminating Company, Limited (44,056).—This company's statutory return was filed on September 19th, when 4,000 shares were taken up out of a capital of £21,000, in £1 shares, and a call of 2s. 6d. per share called and paid.

Bourne and Grant Electricity Supply Company, Limited (38,854).—The registered office of this company was, on September 2nd, removed to 55, Chancery Lane, W.C.

West Australian Electrical Trunk Power and Lighting Company, Limited (45,550).—The registered office of this company was on October 10th fixed at 79, Queen Street, Cheapside, E.C.

Westralian Electric Lighting and Supply Company, Limited (45,136).—This company's registered office was on October 9th removed to 54, Old Broad Street, London, E.C.

CITY NOTES.

Brazilian Submarine Telegraph Company, Limited.

At the meeting held on Wednesday at Winchester House, Sir John Pender, who presided, went over the accounts in the usual way, showing the increase in receipts from all sources as £3,280. The increase he said was due to the growth of the telegraphic business with the West Coast of Africa, South Africa, and the West Coast of South America. He gave figures showing how the company had been enabled to reduce tariffs from time to time. When the word rates came into force the rate to Pernambuco was 9s. a word; it was now 3s. 6d. That to Rio was 13s., to Uruguay 16s. 8d., to Argentine 16s. 4d.; they were now 4s. 6d. Those to Chili and Peru were 21s. 4d. and 21s. 6d. respectively; they were now 6s. 2d. That showed that while the company had been progressing and doing a fairly good business they had also regarded the people who were contributing to their business. The expenditure showed a decrease of £15,643, due to the absence of any heavy cable repairs. Their St. Vincent-Pernambuco cable was broken in August, but was most

speedily repaired (by September 9th), and, when tested afterwards, was found to be in excellent working order, though it had been laid for 21 years. After referring to other general matters, Sir John proceeded to deal with the company's relations with the Brazilian Government, which were not as happy as they would like. For 21 years they gave them an excellent telegraphing service which, he maintained had helped materially to make Brazil what it now is. He thought the Brazilian Government ought to consider that while the pioneer company, which had done so much for them, deserved attention, and should not be treated in the way they had been lately. Sir John went into a lot of details regarding the proposal of that Government to purchase the undertaking of the Western and Brazilian Submarine Company, and said it would be more reasonable and fair if that company were to amalgamate interests with the Brazilian Submarine Company. The matter of the purchase was even now hanging fire and unless something were settled soon, he submitted to the company whether that course would not be the better one. In conclusion he referred to the important question regarding the Island of Trinidad. The Brazilian Government had refused to deal with this company when approached, and they had, therefore, to look about to see how they might keep their traffic open with the Brazils. They looked about to find a way to the Argentine without being interrupted in any way by the Brazilian Government. They found that little island—Trinidad—was unoccupied by anything other than land crabs, though at different times it had been claimed by different nations. They found it would be a most excellent place, providentially given, to carry on their telegraph system. They asked the Government to look into it, and, if it was free, to use it purely for the purpose of progress in submarine telegraphy. The Brazilian Government were attempting to make a political question of it. They were not likely ever to use it if they had it. Let them have suzerainty of it if they pleased, and let it be used by this or any other party. The Brazilian Submarine Company did not ask for exclusion. Let it be kept as a telegraph station for it never could be used for any other purpose. The shareholders would agree with them that nations while they had their rights had also their debts, and, if the Brazilian Government would deal with this company as did the civilised nations of Europe, they would be perfectly satisfied to meet them upon fair terms. Sir John moved the adoption of the report and accounts and the declaration of dividend and bonus, making 7 per cent. for the year, which was unanimously carried.

The retiring directors and auditors were re-elected and the usual vote of thanks closed the meeting.

Eastern Extension Telegraph Company, Limited.

Sir John Pender, G.C.M.G., M.P., presided on Wednesday at the meeting of this company, held at Winchester House. In moving the adoption of the report, he said that the gross receipts for the half-year under review were £264,138, as against £247,681 for the corresponding period of 1894, thus showing an increase of £16,457. That increase was almost entirely due to the activity of the gold mining traffic, which had this year suddenly sprung up with West Australia. A few years ago, the whole of the telegraphic traffic of Western Australia represented only a fraction of the Australian traffic, whereas now it was nearly one-third. Mining business, however, was very speculative, and it was impossible to say whether or not the boom in Western Australia would continue. Meanwhile, the Western and Southern Australian Governments were improving and extending their landline communications, in order to enable them to efficiently deal with the abnormal traffic. The working expenses of the company had amounted to £95,254, as against £80,285 for the corresponding period of 1894, thus showing an increase of £14,959. Of that amount, £8,000 was due to the cable repairs during the past half-year, which were heavier than usual, and the balance was due to special station expenditure. The usual interim dividends at the rate of 5 per cent. per annum had been paid, amounting to £62,500, and the balance of revenue, £70,504, had been carried forward to the next account. With regard to the guaranteed agreement, he said that the fourth year of the working of the guaranteed arrangement with the Australian Government had resulted—for the first time since they had entered into it—in a slight excess over the guaranteed figure. That was due to the exceptionally heavy mining traffic. The results of the previous years' workings were a loss for the first year of £55,040, for the second year of £43,558, and for the third year £12,384, or a total loss of £110,982, half of which was borne by the Government, and the other half by the Eastern Extension and associated companies. The repairs of the cables during the half-year had kept the maintenance ships well employed on the various sections of the company's systems. But the traffic had been in no way interrupted, because the cables were duplicated, and, in some cases, triplicated. There had not been anything of very striking importance during the half-year, but he thought that it was of importance that they had been able to maintain their dividends, and to carry forward a balance and largely increase the reserve fund. He could assure the shareholders that the company's cables were in good working order, the traffic was good, and he thought they might consider the dividend also good. Altogether, the company was in a very satisfactory and prosperous position.

The Marquis of Tweeddale seconded the motion.

The Chairman, in reply to a Shareholder, stated that the list of the company's investments were taken at cost price, and although, as pointed out, their market value was £100,000 in excess of that amount, the company did not take that into account. The expenses were rather heavier than before, but the expenses of such a company could not be accurately gauged beforehand. They had now in hand thelbuilding of a very fine station at Hong-Kong.

The motion was carried unanimously.

The Amazon Telegraph Company, Limited.

The first ordinary general (statutory) meeting was held at Winchester House on Thursday, Mr. W. S. Andrews presiding.

The Chairman said it was a statutory meeting held just to let the shareholders know what progress was being made in what was, practically, an entirely new undertaking. He was pleased to say that all calls had been paid up to the present time. The shares were now £5 10s. paid, with the exception of 914 shares, which were paid up in full. Up to the previous day, the board were informed 1,119 miles of cable had been manufactured, and it was expected that the total mileage would be completed by the end of November, or perhaps even a little earlier. All the apparatus was in hand, and the expedition would, no doubt, start shortly after the completion of the cable, and probably they might see their lines in full working order early in the next year. The contractors and the company's representative had been up the River Amazon for the purpose of surveying the route, fixing the points at which the cable was to be landed, and arranged for the building of huts or small establishments for the offices and quarters, as far as possible, of the clerks employed. The line would be completed early in the coming year. The board had been very mindful to go carefully over the line of route of the cable because of the peculiarity of it, and of the newness of the endeavour to establish a communication of such great length in what was called a river. But the Amazon, where their line terminated at Manaos, was thousands of miles up the river, where it was 10 miles broad; and when the flood season was on, the width of the river was so great that the water was very little affected. During that season the width was about 30 miles, and the river was called the Mediterranean of South America. At to the subsidy, they were advised that it would be paid as soon as they could report that the lines were laid and opened for business, and then the subsidy would date from the contract. The company's representatives had already ordered several telegraphs and telephones, so as to establish communication on different parts of the route.

The Petroleum Engine Company, Limited.

The report of the directors, to be submitted at the meeting of shareholders, to be held on November 5th, 1895, at 3 o'clock in the afternoon, states that the accounts show that the royalties received for the year amount to £683 5s. 6d. The directors regret to have to report that communications were received from Messrs. Priestman Bros., Limited, the licensees of the company, in January last, intimating that in consequence of the severe competition they have been subjected to during the past two years, they found themselves involved in financial difficulties, and that it would be necessary, in the interest of all parties, that their company should be wound up voluntarily, under the supervision of the Court. These steps were taken in the hope that it might be found practicable to reconstruct the company and to continue the business. The directors are led to believe there is reasonable hope that these anticipations will be fulfilled, and that the business of Messrs. Priestman Bros, Limited, will be re-established on a more satisfactory and substantial basis. In the opinion of the directors it would not be prudent at the present time to advise the payment of a dividend. They recommend that the balance of £299 5s. 9d. standing to the credit of the income and expenditure account for the past year be carried forward to the next account. The retiring directors are Mr. Chas. B. B. McLaren, M.P., and Mr. Jarvis W. Barber, who are eligible for re-election. The auditors, Messrs. E. L. Ernest & Co., retire, and are eligible for re-election.

Castner-Kellner Alkali Company, Limited.

The prospectus of this company, which invited up to Friday last subscriptions for 200,000 £1 shares (the authorised capital being 300,000 £1 shares), states that, in view of an arrangement made between the Aluminium Company, Limited, of London, who are the owners of the Castner patents, and Messrs. Solvay et Cie., of Brussels, who are, by purchase, the sole owners of the Kellner patents (except for Austria), the company has been formed for the purpose of working, in Great Britain, Ireland, and the British colonies (excepting Canada), the combined patents of Mr. Hamilton Y. Castner and Dr. Carl Kellner, for the manufacture of caustic alkali and bleaching powder by means of the electrolytic decomposition of salt or alkaline salts. The directors are:—Frederick Burton (of Wm. Burton & Sons), Hamilton Y. Castner (Director of the Aluminium Company, Limited), Frank Hardcastle (Messrs. Thomas Hardcastle & Sons) Carl Kellner, Ph.D. (of the Kellner-Partington Paper Pulp Company, Limited), William Mather, M.I.C.E. (Messrs. Mather & Platt, Limited), Sir Henry E. Roscoe, F.R.S. (Director of the Aluminium Company, Limited). The secretary (*pro tem.*) is Mr. G. H. Clarkson, and the offices 13, Abchurch Lane, E.C.

The Western and Brazilian Telegraph Company, Limited.—The board has decided that, after placing £7,876 to the debenture redemption fund, and £5,000 to the reserve fund, subject to audit, to recommend at the forthcoming meeting a dividend at the rate of £2 10s. per cent. per annum, free of income-tax, for the six months ended June 30th last, as against a dividend at the rate of £2 per cent. per annum for the corresponding period of 1894, carrying forward £5,803. This dividend will be payable as follows:—3s. 9d. per share to the ordinary shares, and 3s. 9d. per share to the preferred ordinary shares.

Elmore's Patent Copper Depositing Company, Limited.

The directors' report, which is to be presented at the meeting to be held to-day, at Leeds, states that the profit on the last year's manufacturing account is £4,587, and after writing off the company's general and trading expenses, the trading account shows a net profit of £2,253 carried to the credit of profit and loss, as against a loss of £6,858 in the previous year. This improvement has been effected without any increase in the company's very inadequate working capital, out of which £5,202 has had to be spent in necessary additions to plant and buildings. The additions to plant are specially valuable, and are working very satisfactorily. Early in the year the board decided to convert into a more readily realisable form a considerable quantity of old manufactured stock on hand at June 30th, 1894, unrealisable immediately as such, and the consequent loss has been eliminated from the year's profit and loss account. The amount, £3,571, after deducting £625, balance of the sheet license royalties in hand, has been added to the balance of deficiency shown at June 30th, 1894. Credit as heretofore is taken in the profit and loss account for £1,250, being the amount of license royalties applicable to the year. Of the managing director's salary £200 has been charged to capital in respect to the new buildings and plant designed and erected by him for the company. The orders received have increased from 706 in the preceding year to 1,531 in the present year—more than double—whilst the deliveries to customers have been nearly four times greater in volume, and practically three times larger in value, notwithstanding that the average selling price has been over £12 per ton lower. This diminution in price is, of course, quite beyond control. It is, however, satisfactory to note that prices are again ruling higher. Comparing the last half-year with the first, the aggregate deliveries to customers to June, 1895, were over three times as large as those to December, 1894. The working expenses show a remarkable decrease with the increase in the business done: in fact, the rate of manufacturing cost has fallen by over 50 per cent. The profit and loss account shows a net profit for the year of £480. That the amount is not larger is chiefly due to two causes—first, to the comparatively small scale of the company's manufacturing operations, owing to its restricted means, as, before raising further capital, the directors were desirous of proving whether or not the company could make a profit even under the most adverse conditions; and, secondly, to certain annual charges entailed upon the company under former administrations in respect to liabilities which are not properly within the sphere of an industrial company, which encroach very seriously indeed upon the profit arising from the company's trading. The business has now reached a stage when further capital can be reasonably asked for and profitably employed in its extension. The shareholders will, therefore, be asked to increase the board's borrowing powers, which are now so largely taken up by the land mortgage—not contemplated when the articles were originally drawn, limiting the borrowing powers to £50,000—as after borrowing £35,000 on the freehold, only a small margin is left. Power to borrow, therefore, as may be required, up to £100,000, will be asked for, and the debentures proposed to be issued will, in the first place, be formally offered to the shareholders. A resolution will also be proposed to reduce the ordinary share capital from £2 to £1 per share. This reduction of capital has no practical disadvantage whatever for the shareholder (as it is intended to arrange with the holders of the preference shares that their interest in the surplus profits shall not be increased at the expense of the ordinary shareholders), but, in fact, affords a distinct gain. The reduction will enable the board to severely write down the capital value of some of the assets, and so diminish the annual charge on future profits for depreciation, and especially it will wipe out entirely the accumulated loss of past years, which would otherwise have to be cleared off out of profits before any distribution could be made to the shareholders, but, by thus reducing the capital, the old loss will no longer appear in the accounts, and the profits can be divided at once as they are made. Moreover, nearly the whole of the proposed reduction has already been returned to the shareholders in dividends.

Chagford and Devon Electric Light Company, Limited.

The annual meeting was held at Chagford on 17th ult.

Mr. Eaton, the chairman, in moving the adoption of the report, said at a first glance the position of the company might appear unfavourable, but that impression would disappear when he reminded them that provision was made for interest on debentures at 7 per cent. Had it not been for this they could have paid a dividend of 3 per cent. on the whole of the nominal capital. He would further remind the shareholders that there were more lights to come, and that would swell the revenue, and he trusted every shareholder would induce his friends to order the light.

Mr. Reeves (of Crompton & Co., London), a director, in seconding the motion, fully endorsed the remarks of the chairman. He said the company were to be congratulated upon having obtained the contract for lighting the streets for the past three years. They were now again tendering for this contract, and from the facilities the company had at their command, he had no doubt the Parish Council would think proper to place the contract again with the company.

Monte Video Telephone Company, Limited.

At the annual meeting of this company, which was held, yesterday, at Winchester House, the Chairman (Mr. H. Ward) said the position of the company, as shown by the accounts, compared favourably with that of last year, in spite of troubles which had befallen them, to which troubles such a company as theirs was peculiarly liable Storms had damaged their wires and posts; the main post at the chief office at Monte Video was struck by lightning in March, and communication with subscribers was for a time totally disconnected; the cost of repair was covered by insurance. The constant changing of posts on roofs of houses, &c., owing to caprice on the part of property holders, was responsible for an extra £800 in the working expenses when compared with last year. The loss of old subscribers was made up for by new. The Police Bureau, which used a number of instruments, had left this company, and been connected to a competitive system. But it had been stated that they had threatened to return, as the new service did not satisfy them. Mr. Sandford, a director of the company, was at present in the River Plate, and was frequently in direct communication with the manager of the company at Monte Video. After referring to the value of the investments, which was satisfactory, he moved the adoption of the report. This was carried, and the retiring director and auditors having been re-elected, the proceedings closed.

Continental Company Notes.

The General Belgian Company for Electrical Undertakings has been created with a capital of 6,000,000 francs, for conducting any business in which electricity plays a part, especially for electric traction. It is founded by the Berlin Company for Electrical Enterprises, the Bank of Dresden, the Bank of Darmstadt, and the Discount Company, and on the other hand by the General Company of Economical Railways, and the General Company of Secondary Railways, both of Brussels.

Bank of Electrical Undertakings.—This company has been formed at Zurich, with a capital of 30,000,000 francs, in order to transform and unify the tramways of Genoa.

Basle Bank for Electric Industry.—This company has been created by Varschauer, Siemens & Halske, the Commercial Bank of Basle, the Basle Bank of Deposit, and the Electric Union of Berlin, in order to conduct any operations of electrical industry.

Electrical Company of Qavour.—This undertaking will have a capital of 180,000 francs, in 260 shares of 500 francs each. The founders introduce into the business an exclusive right for 40 years, the gratuitous cession of a water-power of 266 H.P., a subsidy of 10,000 francs, the installation for public lighting, the gratuitous cession of the gas works, and the certainty of at once supplying more than 1,000 lamps. The town of Qavour has voted the sum of 3,000 francs to obtain supplementary arc lamps.

The French Thomson-Houston Company.—This company's position is better than in the previous year. The company finds a remunerative employment for its capital in electric traction. The directors' report mentions the completion of the electric lines from Lyon to Oulins, the lines of Havre, and those of Belgrade, in Servia. Among the undertakings in progress are the electric tramways from Lyon to St. Fons, and the construction of the net of Rouen. The sale of various apparatus has been remunerative. The company has participated in the re-organisation of the establishments of Postal Vinay, which came into operation on October 6th, 1894. The company, during the season, has made a call of 125 francs on each share. The shares are now half paid up

Victoria Electric Railway and Lighting Company, Limited.—Messrs. Sperling & Co., the London agents of this company, have given notice that a meeting of the debenture-holders will be held at 8, Austin Friars, London, E.C., on Wednesday, November 6th, 1895, at 2 o'clock p.m.

Eastern and South African Telegraph Company, Limited.—On November 15th, at noon, at the offices, Winchester House, Old Broad Street, E.C., 381 5 per cent. mortgage debentures will be drawn for payment on January 1st.

The Indo-European Telegraph Company, Limited.—The directors have declared an interim dividend for the half-year ended June 30th last, at the rate of 5 per cent. per annum, free of income-tax, payable on and after the 1st prox.

The Telephone Press, Limited.—At a meeting held at 9, Arundel Street, Strand, on October 25th, it was resolved to wind the company up voluntarily, Mr. Leonard Tuke, of Talbot House, Arundel Street, being appointed liquidator.

Stock Exchange Announcements.—The Committee has ordered Edison & Swan United Electric Light Company, Limited, 17,139 "A" shares, Nos. 01 to 017,139, to be quoted in the Official List.

Metropolitan Electric Supply Company, Limited.—The transfer registers will be closed from to-day until Friday next, both days inclusive, for payment of an interim dividend.

TRAFFIC RECEIPTS.

The City and South London Railway Company. The receipts for the week ending October 27th, 1895, amounted to £977; week ending October 28th, 1894, £948; increase, £29; total receipts for half-year, 1895, £14,678; corresponding period, 1894, £14,811; decrease, £133.

The Liverpool Overhead Railway Company. The receipts of this railway for the week ending October 27th, 1895, amounted to £1,075; corresponding week last year, £901; increase, £174.

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending October 25th, 1895, after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited, were £3,203.

SHARE LIST OF ELECTRICAL COMPANIES.

TELEGRAPH AND TELEPHONE COMPANIES.

Present issue	NAME.	Stock or Share. ‡	Dividends for the last three years. 1892.	1893.	1894.	Closing Quotation Oct. 16th.	Closing Quotation, Oct. 30th.	Business done during week ended Oct. 30th, 1895. Highest.	Lowest.
173,400*l*	African Direct Teleg., Ltd., 4 % Deb.	100	...	4 %	4 %	102 —105	102 —105	104	...
1,012,880*l*	Anglo-American Teleg., Ltd.	Stock	£2 15s.	£2 11s.	£2 2s.	45 — 47 xd	44 — 46	45½	...
2,993,560*l*	Do. do. 6 % Pref.	Stock	£5 10s.	£5 2s.	£4 4s.	86 — 87 xd	85 — 86	85½	84
2,993,560*l*	Do. do. Defd.	Stock	...	...	...	7⅞ — 7¾	6⅞ — 7⅛	7⅛	...
130,000	Brazilian Submarine Teleg., Ltd.	10	6¼% §	6¼% §	...	14 — 14½	14 — 14½	14 5/16	...
75,000*l*	Do. do. 5 %, Debs., 2nd series, 1906	100	5 %	5 %	...	111 —115	111 —115	...	...
44,000	Chili Telep., Ltd., Nos. 1 to 44,000	5	10%‖ §	... §	2½%	3½ — 4	3½ — 4	...	...
10,000,000$	Commercial Cable Co.	$100	7 %	7 %	7 %	164 — 168	164 —168	...	...
224,850	Consolidated Telep. Const. and Main., Ltd.	10/-	2 % §	2 % §	1½%	1/16 — 3/16	1/16 — 3/16	...	...
16,000	Cuba Teleg., Ltd.	10	8 %	8 %	8 %	13 — 14	13 — 14	13½	13
6,000	Do. 10 % Pref.	10	10 %	10 %	10 %	20½ — 21½	20½ — 21½	...	...
12,931	Direct Spanish Teleg., Ltd.	5	4 %	4 %	4 %	4 — 5 xd	4 — 5	...	...
6,000	Do. do. 10 % Cum. Pref.	5	10 %	10 %	10 %	9¾ — 10¼	10 — 10½	10½	...
30,000*l*	Do. do. 4½ % Debs. Nos. 1 to 6,000 ...	50	...	...	4½%	104 —107	104 —107	...	...
60,710	Direct United States Cable, Ltd.	20	3½% §	2⅞% §	2 %	8⅞ — 9¼xd	8⅞ — 9¼xd	9	8⅞
400,000	Eastern Teleg., Ltd., Nos. 1 to 400,000	10	6½% §	6½% §	6½%	17⅛ — 17⅜xd	17 — 17½	17 5/16	17
70,000	Do. 6 % Cum. Pref.	10	6 % §	6 % §	6 %	18 — 18½xd	18 — 18½xd	18	...
102,100*l*	Do. 5 % Debs., repay. August, 1899	100	5 %	5 %	5 %	107 —110	107 —110	...	...
1,297,837*l*	Do. 4 % Mort. Deb. Stock Red.	Stock	4 %	4 %	4 %	129 —132	127 —130	...	...
250,000	Eastern Extension, Australasia and China Teleg., Ltd. ...	10	7 %	7 %	7 %	18 — 18¼xd	17⅜ — 18¼	18¼	18
54,100*l*	Do. 5 % (Aus. Gov. Sub.), Deb., 1900, red. ann. drgs. reg. 1 to 1,049, 3,976 to 4,326	100	5 %	5 %	5 %	103 —107	103 —107	...	...
194,300*l*	Do. do. Bearer, 1,050—3,975 and 4,327—6,400	100	5 %	5 %	5 %	104 —107	104 —107	...	...
220,000*l*	Do. 4 % Deb. Stock	Stock	4 %	4 %	4 %	128 —131	128 —131	...	...
80,600*l*	Eastern and South African Teleg., Ltd., 5 % Mort. Deb. 1900 redeem. ann. drgs., Reg. Nos. 1 to 2,343	100	5 %	5 %	5 %	103 —107	103 —107	...	...
107,600*l*	Do. do. do. to bearer, 2,344 to 5,500	100	5 %	5 %	5 %	104 —107	104 —107	...	...
300,000*l*	Do. 4 % Mort. Debs. Nos. 1 to 3,000, red. 1909	100	4 %	4 %	4 %	108 —111	108 —111	...	...
200,000*l*	Do. 4 % Reg. Mt. Debs. (Mauritius Sub.) 1 to 8,000	25	4 %	4 %	4 %	114 —117%	114 —117 %	114½	...
180,227	Globe Telegraph and Trust, Ltd.	10	4⅞% §	4⅝% §	4⅛%	10⅛ — 10⅜	10 — 10¼	10 7/16	10⅛
180,042	Do. do. 6 % Pref.	10	6 % §	6 % §	6 %	17 — 17½	16⅞ — 17⅛	17½	17
150,000	Great Northern Teleg. Company of Copenhagen	10	8⅜% §	8⅜% §	8⅜% §	21⅜ — 22¼	21⅜ — 22¼	22⅛	..
180,000*l*	Do. do. do. 5 % Debs.	100	5 %	5 %	5 %	103 —106	104 —107	106	...
17,000	Indo-European Teleg., Ltd.	25	10 %	10 %	10 %	50 — 53	48 — 51	50½	...
100,000*l*	London Platino-Brazilian Teleg., Ltd. 6 % Debs.	100	6 %	6 %	6 %	106 —110	106 —110	..	...
28,000	Montevideo Telephone 6% Pref., Nos. 1 to 28,000...	5	...	...	...	2 — 2⅛	2 — 2⅛	...	...
484,597	National Teleph., Ltd., 1 to 484,597	5	5 % §	5 % §	5 %	6⅛ — 6⅜	6 — 6¼	6⅜	6⅛
15,000	Do. 6 % Cum. 1st Pref.	10	6 %	6 %	6 %	16 — 18	16 — 18	..	...
15,000	Do. 6 % Cum. 2nd Pref.	10	6 %	6 %	6 %	15 — 16	15½ — 16½	16 1/16	15¾
119,234	Do. 5 % Non-cum. 3rd Pref., 1 to 119,234	5	5 %	5 %	5 %	6¼ — 6½	6¼ — 6½	...	...
1,100,000*l*	Do. 3½ % Deb. Stock Red.	Stock	3½%	3½%	3½%	106 —108	106 —108	107½	106⅛
171,504	Oriental Teleph. & Elec., Ltd., Nos. 1 to 171,504, fully paid	1	...	...	4¼%	9/16 — 11/16	9/16 — 11/16	...	
100,000*l*	Pacific and European Tel., Ltd., 4 % Guar. Debs, 1 to 1,000	100	4 %	4 %	4 %	109 —112	109 —112	...	..
11,839	Reuter's Ltd.	8	5 %	0 %	*nil*	5½ — 6½	5½ — 6½xd	...	...
3,381	Submarine Cables Trust	Cert.	...	...	...	127 —132	127 —132	...	...
58,000	United River Plate Teleph., Ltd.	5	...	...	...	2⅜ — 3¼	2⅜ — 3¼	...	...
146,733*l*	Do. do. 5 % Debs.	Stock	5 %	5 %	5 %	92 — 97	92 — 97	...	...
15,609	West African Teleg., Ltd., 7,501 to 23,109	10	...	...	*nil*	5½ — 6½	5½ — 6½	6⅛	5⅞
238,300*l*	Do. do. do. 5 % Debs.	100	5 %	5 %	5 %	104 —107	104 —107	...	...
30,000	West Coast of America Teleg., Ltd.	10	...	...	...	1½ — 2	1½ — 2	..	...
150,000*l*	Do. do. do. 8 % Debs., repay. 1902	100	8 %	8 %	...	100 —105	100 —105	101½	..
64,248	Western and Brazilian Teleg., Ltd.	15	2½%	2½%	3 %	10½ — 10⅝	10½ — 10⅝	10½	10 7/16
33,129	Do. do. do. 5 % Pref. Ord. ...	7½	5 %	5 %	5 %	6½ — 7	6½ — 7	6⅞	6 13/16
33,129	Do. do. do. Def. Ord.	7½	...	...	1 %	3⅜ — 4¼	3½ — 4	4 3/16	3 15/16
165,200*l*	Do. do. do. 6 % Debs. "A," 1880 Red.	100	6 %	6 %	6 %	103 —107	103 —107	...	...
206,400*l*	Do. do. do. do "B," do.	100	6 %	6 %	6 %	103 —107	103 —107	...	...
88,321	West India and Panama Teleg., Ltd.	10	⅛%	⅜%	⅛%	⅜ — 1	7/16 — 1⅛	1 1/16	...
34,563	Do. do. do. 6 % Cum. 1st Pref.	10	6 %	6 %	6 %	10¼ — 10⅜	10¼ — 10⅜	10 1/16	...
4,669	Do. do. do. 6 % Cum. 2nd Pref.	10	6 %	6 %	6 %	8½ — 9½	8½ — 9½	...	...
80,000*l*	Do. do. 5 % Debs. No. 1 to 1,800 ...	100	5 %	5 %	5 %	111 —114	111 —114	...	...
1,777,000$	Western Union of U. S. Teleg., 7 % 1st Mort. Bonds ...	$1000	7 %	7 %	7 %	113 —118	113 —118	...	...
164,300*l*	Do. do. 6 % Ster. Bonds.	100	6 %	6 %	6 %	100 —103	100 —103	...	...

ELECTRICITY SUPPLY COMPANIES.

30,000	Charing Cross and Strand Electy. Supply	5	5 %	4½%	4½%	5½ — 5⅝	5½ — 5⅝	5⅝	5 5/16
10,277	*Chelsea Electricity Supply, Ltd., Ord., Nos. 1 to 10,277 ...	5	...	...	...	6⅞ — 7¼	6⅞ — 7¼	...	...
60,000	Do. do. do. 4½ % Deb. Stock Red. ...	Stock	...	...	...	116—119	116 — 119	...	...
40,000	City of London Elec. Lightg. Co., Ltd., Ord. 40,001—80,000	10	...	...	5 %	13 — 14	13 — 14	...	...
40,000	Do. do. 6 % Cum. Pref., 1 to 40,000	10	6 %	6 %	6 %	15 — 16	15½ — 16½	16¼	15¾
300,000	Do. 5 % Deb. Stock, Scrip. (iss. at £115) all paid	...	5 %	5 %	5 %	133 —137	133 —137	135½	133
22,475	County of London and Brush Prov. Elec. Ligtg., Ltd., Ord. 1—22,475	10	...	...	...	8½ — 9½	8½ — 9½	...	...
10,000	Do. do. do. 6% Pref., £6 pd., 40,001—50,000	10	...	...	...	8⅞ — 9¼	8⅞ — 9¼	...	...
50,000	†Liverpool Electric Supply, all paid	5	5 %	5 %	5⅛%	7⅞ — 8⅛	7⅞ — 8⅛	...	...
49,900	*Metropolitan Electric Supply, Ltd., 101 to 50,000 ...	10	2 %	2½%	3 %	11¼ — 10⅝	11 — 11½	11⅜	11¼
150,000*l*	Do. 4½% first mortgage debenture stock	...	4½%	4½%	...	117 —119	117 —120	115½	...
6,452	Notting Hill Electric Lightg. Co., Ltd.	10	...	...	1 %	8½ — 9½	8½ — 9½	...	...
19,980	St. James's & Pall Mall Elec. Light Co., Ltd., Ord., 101-20,080	5	7½%	4½%	6½%	8¼ — 8⅝	8¼ — 8⅝	8⅜	...
20,000	Do. do. 7 % Pref., 20,081 to 40,080	5	7 %	7 %	7 %	9 — 10	9 — 10	...	...
67,900	*Westminster Electric Supply Corp., Ord., 101 to 60,000 ...	5	3½%	4 %	5 %	8½ — 9	8¼ — 8⅝	8 13/16	8¼

* Subject to Founder's Shares. † Quotations on Liverpool Stock Exchange.

Unless otherwise stated all shares are fully paid. ‖ Dividends paid in deferred share warrants, profits being used as capital.

Dividends marked ‡ are for a year consisting of the latter part of one year and the first part of the next.

SHARE LIST OF ELECTRICAL COMPANIES—*Continued.*

ELECTRICAL RAILWAY, MANUFACTURING, AND INDUSTRIAL, COMPANIES.

Present Issue.	NAME.	Stock or Share. ‡	Dividends for the last three years. 1892.	1893.	1894.	Closing Quotation, Oct. 23rd.	Closing Quotation, Oct. 30th.	Business done during week ended Oct. 30th, 1895. Highest.	Lowest.
90,000	Brush Elecl. Enging. Co., Ord., 1 to 90,000...	3	6 % §	6 % §	...	1½— 1⅝	1½— 1⅝	2	1½
90,000	Do. do. Non-cum. 6 % Pref., 1 to 90,000	2	6 % §	6 % §	...	2 — 2¼	2 — 2¼	2 3/16	2 1/16
125,000*l*	Do. do. 4½ % Perp. Deb. Stock.... ...	Stock	4½%	4½%	...	112 —115	112 —115	...	...
630,000*l*	City and South London Railway	Stock	8%	8%	1¼%	38 — 40	40 — 42	41	39
28,180	Crompton & Co., Ltd., 7 % Cum. Pref. Shares, 1 to 28,180	5	7 % §	7 % §	...	1½— 2½	1½— 2½	...	...
89,261	Edison & Swan United Elec. Lgt., Ltd., "A" shrs, £3 pd. 1 to 89,261	5	...	...	5 %	1⅞— 2¼	1⅞— 2¼	...	...
100,000	Do. do. do. 4½% Deb. Stock Red....	Stock	...	...	4½%	104 —107	104 —107	...	...
110,000	Electric Construction, Ltd., 1 to 110,000	2	*nil*	*nil*	*nil*	⅝— ⅞	¾— 1	...	...
12,845	Do. do. 7 % Cum. Pref., 1 to 12,845 ...	2	7 %	7 %	7 %	2 — 2½	2 — 2½xd	...	...
91,195	Elmore's Patent Cop. Deposg., Ltd., 1 to 70,000	2	*nil*	*nil*	...	⅜— 1	⅝— ⅞	13/16	11/16
69,385	Elmore's Wire Mfg., Ltd., 1 to 69,385, issued at 1 pm. ...	2	*nil*	*nil*	...	⅝— 1⅛	⅝— 1⅛	...	...
20,000	Fowler-Waring Cables, Nos. 301 to 20,300	5	*nil* §	*nil* §	...	¼— ⅜	¼— ⅜	...	...
9,600*l*	Greenwood & Batley, Ltd., 7 % Cum. Pref., 1 to 9,600 ...	10	7 %	*nil*	...	6½— 7½	6½— 7½	...	...
10,000	Henley's (W. T.) Telegraph Works, Ltd., Ord.	10	5 %	5 %	6 %	14½— 14⅝	14 — 14½	14½	14½
3,000	Do. do. do. 7% Pref.	10	...	...	...	15½— 16½	15½— 16½xd	16½	16⅜
50,000	Do. do. do. 4½ Mort. Deb. Stock	Stock	...	...	...	107 —110	107 —110	110	...
50,000	India-Rubber, Gutta Percha and Teleg. Works, Ltd. ...	10	12½%	12½%	10 %	19 — 20	19 — 20	19⅝	19⅛
200,000*l*	Do. do. do. 4½ % Deb., 1896	100	4½%	4½%	4½%	100 —102	100 —102xd	...	...
37,500	†Liverpool Overhead Railway, Ord.	10	...	1 %	1½%	11⅜— 11⅞	11⅝— 12 1/16	...	...
10,000	† Do. do. Pref., £10 paid	10	...	5 %	5 %	15 — 15½	15 — 15½	...	...
37,350	Telegraph Constn. and Maintce., Ltd.	12	15 %	20 %	20 %	43 — 45	43 — 45	44½	43
150,000	Do. do. do. 5 % Bonds, red. 1899	100	5 %	5 %	5 %	104 —107	104 —107	...	...
54,000*l*	Waterloo and City Railway, Nos. 1 to 54,000, £4 paid ...	10	...	...	...	4⅝— 4⅞	4⅝— 4⅞	...	...

† Quotations on Liverpool Stock Exchange. ‡ Unless otherwise stated all shares are fully paid. ¶ Last dividend paid was 50°/ for 1890.

Dividends marked § are for a year consisting of the latter part of one year and the first part of the next.

Crompton & Co.—The dividends paid on the ordinary shares (which have not a Stock Exchange quotation), are as follows: 1892—6°/₀; 1891—7°/₀§ 1890—8°/

LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED.

Birmingham Electric Supply Company, Ordinary of £5 (fully paid), 5⅜—6¼.

Electric Construction Corporation, 6 % Debentures, 98—102.

House-to-House Company (£5 paid), 4¼—4⅜.

Do. do. 7 % Preference, of £5, 8—8½.

Do. do. 4½% Debentures of £100, 110—112.

Kensington and Knightsbridge Electric Lighting Company, Limited, Ordinary Shares £5 (fully paid) 8—8½; 1st Preference Cumulative 6 %, £5 (fully paid), 7—7½.

Liverpool Electric Supply, £5 (fully paid), 7⅞—8⅛.

London Electric Supply Corporation, £5 Ordinary, ⅜—⅝.

Yorkshire House-to-House Electricity Company, £5 Ordinary Shares fully paid, 6½—7.

Bank rate of discount, 2 per cent. (February 22nd, 1894).

ELECTRIC TRACTION IN AUSTRALIA.

[FROM OUR OWN CORRESPONDENT.]

The subject of electric traction for Sydney has been very much discussed of late, Mr. Eddy, the Chief Railway Commissioner, having returned from his trip to England as delegate to the Railway Conference quite a convert to the facilities of rapid transit afforded by electricity. The latest contribution to the question is a report to the Minister for Public Works by Mr. Deane, Engineer-in-Chief of the Railway Construction Branch, as follows:—The proposed scheme embraces the construction of several new lines, and the conversion of the greater part of the existing lines from steam to electric traction, leaving the outlying portions of the longer lines to be worked by steam. There are in all 11 new lines proposed, of which six are to be worked by electricity, three by cable and two by steam. The new lines to be worked electrically are as follows:—

1. From Miller's Point *via* George Street to Harris Street, where it will verge into the existing steam tramway. This line would accommodate all the traffic from the western suburbs; estimated cost, £107,091; length about 2¼ miles.

2. From Circular Quay *via* Pitt Street Garden Road, new street through cemetery to the corner of Devonshire Street and Castlereagh Street, Redfern. On this line the whole of the railway and Botany traffic would be carried, thereby greatly relieving the congestion on Elizabeth Street which would then only carry the eastern suburbs traffic instead of carrying, as at present, the whole of the traffic, except that carried by the Ocean street cable tram; estimated cost, £102,510; distance about 1¾ miles.

3. From Circular Quay to Nilson's Point, North Sydney, by means of tunnel under the harbour, and thereby giving direct connection between the Redfern and Nilson's Point Railway stations. Two alternative routes are shown for the tunnel, one *via* Fort Macquarie, and the other *via* Dawes Point. The best location will have to be determined after detail, survey, and borings have been taken; estimated cost, £372,611; distance about ¾ mile, of which about 550 yards would be actually sub-aqueous *via* Dawes Point, and 770 yards *via* Fort Macquarie.

4. A branch from the George Street tramway, at the intersection of Essex Street, by means of a sub-aqueous tunnel to Balmain; this would bring this densely populated suburb into direct connection with the city by a short tram route. This traffic is now served by a tram taking a very round-about route, and also largely by ferry boats. Estimated cost £258,640; distance about 1 mile, of which about 660 yards would be actually under water.

5. From Spit Road, North Sydney, to the waters of Nosman's Bay; estimated cost £13,190, distance about 1¼ mile.

6. From Spit Road terminus, to the Spit, Middle Harbour; estimated cost £23,380, distance about 1½ mile. This line would no doubt be eventually extended to Manly.

It is proposed that a central station be erected at the head of Darling Harbour for working all lines on the southern side of Port Jackson; the lines on the north shore being worked from the present power house, which would be remodelled for the purpose, the present cable tramway being converted into an electric tramway.

The approximate estimated cost of the complete system as described is as follows:—

Track construction:	New electric lines	£647,902
	Duplicating existing lines ...	35,270
	New steam lines	63,126
	New cable lines	101,347
	New electric lines, North Sydney	19,140
Buildings, chimneys and engine foundations ...		150,694
Power plant, city and suburbs		144,100
Rolling stock		415,888
Distribution of power		126,940
Distribution of power, rolling stock, and alteration in power plant, North Sydney		43,340
Total		£1,748,047

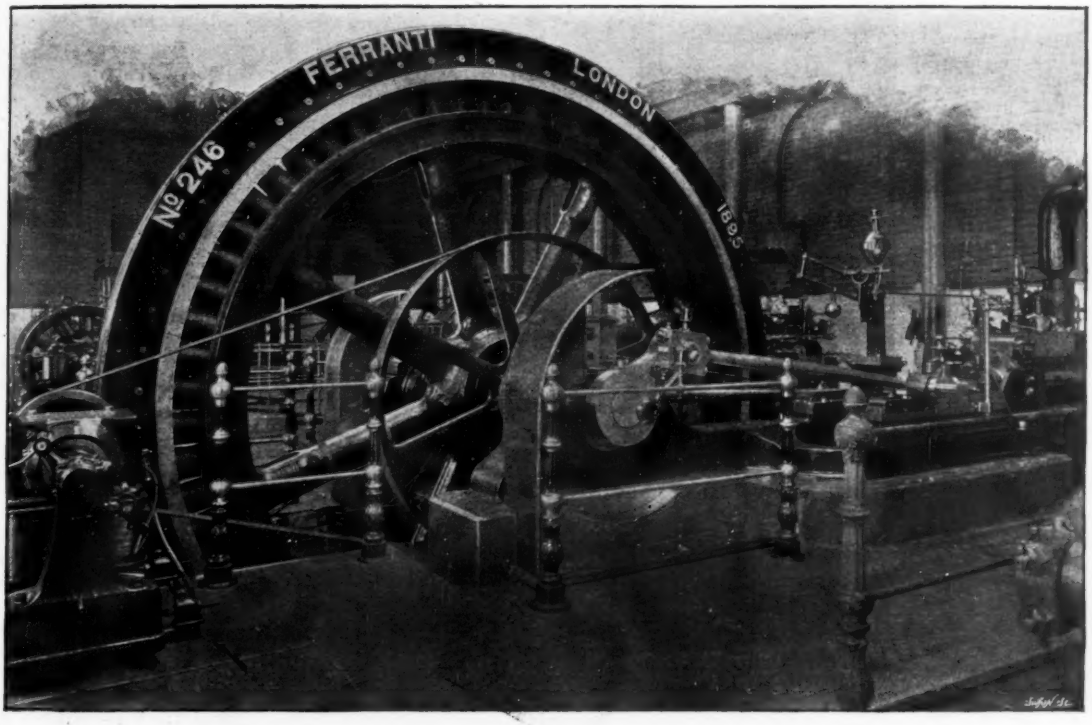
Mr. Deane adds that, of course, the above figures are only correct if the whole of the scheme is carried out. The cost increases in about the same ratio as the number of miles dealt with decreases. For example, take the George Street tramway. According to the above figures its cost would be £107,000, while if it were carried out quite independently, the cost would be £140,000. The estimate does not cover land resumption; but it is estimated that on account of land required being mostly located in the suburbs, the cost thereof will certainly not add more than 10 per cent. to the total cost of the scheme. As to the probability of the scheme being a paying one, the total capital—that is, the cost of existing and proposed new tramways on which interest would have to be paid—would amount to about £3,000,000 sterling. Taking as a basis the earnings of the year 1893-4 on the lines affected to have been about £230,000, Mr. Deane is of opinion that this would be fully doubled—that is to say, £460,000. To arrive at the probable expenditure it is assumed that five times as many car miles would have to be run as tramway train miles were run in the year above mentioned, viz., about 8,700,000 car miles, which at 6d. per car mile would amount to £217,500 per annum, which would leave net earnings amounting to £242,500. This would pay interest at the rate of about 8 per cent. per annum, on a capital of £3,000,000 sterling.

Sydney, *September 23rd*, 1895.

EXTENSION OF ELECTRIC LIGHTING AT SOUTHPORT.

Electrical contractors are fairly alive to the fact that the soundest business lies in extending existing lighting works rather than building new ones. Extensions suggest that works have already achieved some measure of success, and it is much easier to make good contracts under such circumstances than in the case of a new undertaking. The experience gained in working a station goes for something; the conditions of the place as regards lighting are better understood, with a consequence that there is more judgment in the selection of plant.

It is a curious fact that wherever there have been extensions there is, as a rule, a departure from the original plant. We do not know that this can be held to show a lack of faith in the old machinery; it may be that there is something newer in the market, or it may be considered that change has its advantages.



Southport.—Fly-wheel Alternator.

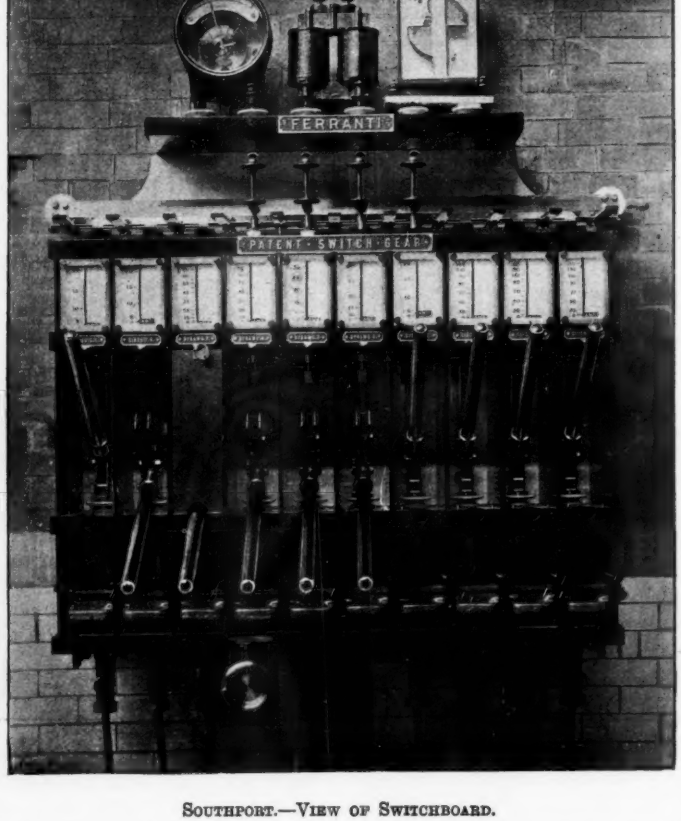
The extensions of public lighting works have become of great importance. As a matter of fact, if they were not general it would be a serious thing for the industry, for in the very nature of things there should be a steady growth in the output and a corresponding increase in machinery.

The Southport Corporation Electricity Works have not been open much more than a year, but the demand for electric energy beyond what could be supplied has been so great, that considerable additions to plant have been necessary. These have been recently commenced, and the works are now equipped with plant capable of supplying 12,500 8-C.P. lamps. When we described the original works of the Southport Corporation nearly 12 months ago, the plant consisted of two 60-unit and one 25-unit alternators, driven by two 100 and one 55-H.P. engines. The capacity of the station was at that time rated at 4,500 lamps. We then pointed out that considering the extremely favourable conditions which obtained in Southport the works were unduly small, and that the demand would soon exceed the supply. The truth of this was very soon apparent to the Electric Lighting Committee,

for less than four months after the opening it was decided to make extensions.

Having in view our previous account of the Southport work, it is hardly necessary to do more than mention the fact that the generating station is near the old gas works at Blowick, some 2½ miles from the centre of the town. The high pressure alternating current at 2,000 volts is brought to various transforming points in the town, from whence distribution is effected on the three-wire system.

The original alternators are driven by Browett & Lindley engines of the compound horizontal type. The revolving part of the machine is the armature, the magnets being fixed. In order to show the difference in this type of plant, and the new machines which have been erected, we reproduce a view of the works when they were completed last year; the best idea of the relative sizes, however, is obtained from the large illustration, which shows the large Ferranti fly-wheel alternator, with the Mather & Platt machines behind. When considering the question of increasing the works, the Electric Lighting Company were much impressed with the success of the fly-wheel alternators which had been erected at Portsmouth, especially as street lighting had been decided upon.



Southport.—View of Switchboard.

The extensions consist of a 250 H.P. boiler, two fly-wheel alternators, each of 125 units, and two 250-H.P. engines. At the present moment only one of the combinations is actually at work, though it is not anticipated that the second machine will be long in erecting.

The engines, which have been made by Messrs. Musgrave and Sons, of Bolton, are of the horizontal compound side by side type, the condensing apparatus being separate from the engines. They are made to work either condensing or non-condensing, as the necessity arises. The cylinders are 12½ inches and 25 inches diameter by 3 feet stroke. They are capable of developing 250 I.H.P. each when working at a boiler pressure of 140 lbs. per square inch, running at 96 revolutions per minute. The crank shafts are of Siemens steel, with necks 8 inches diameter, 16 inches long, swelled to 12 inches diameter at the centre. The valves are on the Corliss principle, actuated by the makers well-known type of valve gear. In all cases the valves are double ported, which enables the steam to get in and out of the cylinders very quickly.

The high pressure valve gears are coupled direct to highly sensitive quick-speed governors, to which are coupled adjustable balance balls, so that the engines can be regulated to any required speed. The crank-shaft steps are in four parts, and lined with white metal; the crank pin steps are made so that they can swivel round a little if necessary, and not cause any undue friction on the crank pin; these are also lined with white metal. The oiling arrangements are very complete; oil guards are provided very extensively all round the cranks, eccentrics, between the slides, under all the valve spindles, and, in fact, wherever necessary.

New steam, exhaust, feed, and injection pipes, have been supplied, all the old steam pipes being taken out, so that the engines can be worked together or separate, as desired; the steam pipe is on the ring system. The first engine has been working non-condensing since the starting of the plant, and as much as 287 I.H.P. has been on at one time, although the engine is only intended to drive 250 I.H.P. when working with the condenser.

As at Portsmouth and other places, where the fly-wheel alternator has been erected, the field magnets are mounted on the rim of the fly-wheel.

The alternator has a stationary armature and revolving magnets. It is capable of giving an output continuously of 125 units at a pressure of 2,000 volts, it runs at a speed of 96 revolutions per minute, and has a periodicity of 50 cycles per second.

The alternator is of the same type as those installed by Messrs. Ferranti, Limited, at Portsmouth, and which have given such great satisfaction to the Electric Lighting Committee of that town. The armature frame is a massive U-shaped casting divided into four sections bolted together. There are 32 armature sections, which are made up of a number of laminated Swedish iron stampings. There are tunnels stamped through the armature sections through which are first put mica tubes, the armature windings being threaded through these mica-lined tunnels. Each section is bolted to the armature frame, and the armature conductors are enclosed in a dust and water-proof metal box, lined through with cased ebonite, thus ensuring the protection of the armature winding from external injury.

The field magnets are spaced equally round the periphery of a wheel 13 feet diameter, which is keyed direct on to the centre of the engine shaft. The magnets are circular in shape, the coils being wound on Messrs. Ferranti's now well known plan, which consists of copper strip wound edgeways. Between each layer there is a washer of insulating material, and a heavy fibre washer insulates each magnet coil from the fly-wheel. This method of winding, allowing the quickest radiation of heat generated, keeps the field maghets very cool.

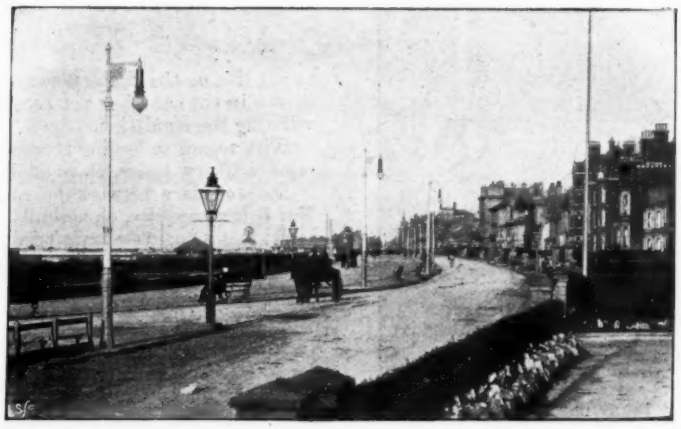
There are, as stated above, two of these alternators to be installed, but as we have already said, only one is working.

The Southport Corporation, when considering the extensions, decided to abandon the system of switching gear which they had in use at their central station from the commencement of their working until just recently, and placed with Messrs. Ferranti, Limited, an order for a main switchboard capable of dealing with five alternators and exciters and five circuits. This board is divided into panels, each panel being for either an alternator or circuit, the only difference being that each alternator switch has on it an additional contact, which is for the purpose of synchronising, should it be desired to put the alternator it controls into parallel with any one or the whole of the other alternators.

There is no wood work or anything else about this board which is inflammable, all the parts being either slate, porcelain, or metal, and there are no back connections, the back of the board being built direct in the engine room wall. There are one or two features about this board which are novel, the chief of which is a new ampèremeter made after the designs of Mr. Ferranti; one of its chief merits is a scale which can be read, and a needle which moves vertically instead of describing more or less the segment of a circle.

There are also two Ferranti rectifiers, either of which is capable of supplying 40 15-ampère arc lamps in series. These rectifiers are similar to those already installed at Portsmouth, Blackpool, Edinburgh and Tunbridge Wells, and those which Messrs. Ferranti have in hand for Islington and South Shields; they are identical with those described in the ELECTRICAL REVIEW of October 18th.

It is obvious from what we have just said that street lighting by electricity has been adopted at Southport. As a matter of fact, the street lighting is now one of the best features of the town, though not more than two or three of the principal streets are yet supplied with arc lamps. Altogether there are 40 double carbon lamps, each of 2,500-candle-power. They are placed 50 yards apart, consequently the illumination is distinctly good. These 40 lamps are arranged on two circuits, each lamp being on alternate circuits. Half of the lamps are extinguished at 11.30, *i.e.*, every other one. It was the original intention of the Lighting Committee to provide each lamp pillar with two incandescent lamps, similar to the arrangement at Portsmouth, which could be used from midnight. It was computed, however, that the arrangement would be more expensive than using half the arc lamps, and the idea was therefore abandoned. The lamps which are employed are of the Crompton-Pochin type, and the lamp pillars have been made by Messrs. McKenzie. The lighting of the streets is confined to the Promenade and Lord Street, though it is the intention of the committee to proceed in the lighting of other principal streets as soon as possible. Customers for electric light increase so rapidly in Southport, that there is not expected to be much margin left when the whole of the extensions are completed.



SOUTHPORT.—ARC LAMPS ON THE PROMENADE.

The addition of the 250 H.P. boiler brings the boiler power up to 750 H.P. A condensing plant and economiser have been added. Messrs. Browett & Lindley have supplied the former, Messrs. Roberts Bros., of Dukinfield, having supplied the economiser, which consists of 192 pipes arranged in two sections of 96 pipes each, which are connected with expansion pipes. All the upright pipes are cast in vertical dry sand moulds, ensuring a thoroughly clean pipe inside and out. The scrapers are of the most approved type, and are worked by a small engine fixed on the boiler house floor, easily accessible to the fireman. Water for condensing purposes is obtained from an adjoining stream, the rent charged being a nominal one.

With regard to expenditure, the Corporation, when they built the original plant, had borrowed £28,000; £18,476 was spent on the original plant, leaving a balance of £9,524. To carry out extensions, the Corporation borrowed an additional £15,500, which brings up the total borrowing powers to £43,500.

As in the original plant the whole of the work has been carried out under the superintendence of Mr. Arthur Ellis, the borough electrical engineer, who is to be congratulated on the success that has attended his efforts, especially in promoting street lighting.

THE CONTROL OF TRANSFORMER LOSSES ON CONVERTING SYSTEMS OF ELECTRICAL SUPPLY.

BY JAMES WHITCHER, A.I.E.E.

(*Continued from page* 525.)

5. Sub-stations with transformers, fed by two or more primary circuits, with automatic switches on the secondary side only, and arranged to be actuated by the making or breaking of the primary circuits. The arrangement comprises separate transformers or groups on each primary circuit, all feeding into a common set of secondary mains, each through a switch. The automatic mechanism may be set in action by a relay, as in Mr. Geipel's system, Patent, No. 6,666, 1893, or directly by reversal in the flow of energy to and from the transformer, as in Mr. Lowrie's, No. 3,666, 1893. In either case the signal from the central station for the mechanism to act is a clear and decisive one, and it may be repeated as desired, by making and breaking the primary circuit, until it is found that the switching is accomplished. A voltmeter across the station end of the circuit will show this, in case of bringing the circuit and its attached transformer into work; the circuit ammeter is the guide in the reverse case. Two primary circuits into each sub-station suffice for a single graded change-over; they may have a common return, and for street box sub-stations one pair of circuits may feed several points. A system of this class, with three-wire low pressure mains, was adopted in the Bedford supply scheme.

6. The simpler case of the author's system, as applicable for use with continuous or simple alternating currents. By means of mains, both primary and secondary, arranged on the "three," or other multiple wire principle, combined with a suitable disposition of the transforming plant, it contrives to dispense with any switches whatever at the sub-stations, the converting plan remaining in permanent connection with the mains. A simple switching operation on the primary mains at the central station, puts portions of the transforming plant in or out of active service as desired, without any further apparatus or complication than are necessary for methods No. 5 above, without the secondary switches. It is described in detail further on; for the purpose of this brief enumeration, we pass on to the next and last method.

7. The author's system, in its mathematically more general case, though applicable for use only with two or multi-phase alternating currents. This system uses a similar arrangement of mains and converting plant, to the one previous; but, by supplying the sides of the primary main system with E.M.Fs. at a relative phase difference, which can be varied at will through all values, from consonance to oppositeness, the effective capacity or activity of the plant can also be varied through all values from a minimum to a maximum. It differs, therefore, from all other methods in having a complete and continuous range of changes, in place of the one, or at most two changes, that are practicable with them. Further, the means of performing the operation are all located at the central station, under the engineer's control.

. . . . . .

Our general survey of the present position of the problem of controlling converting losses is now complete, and we may pass on to a detailed description of the author's systems.

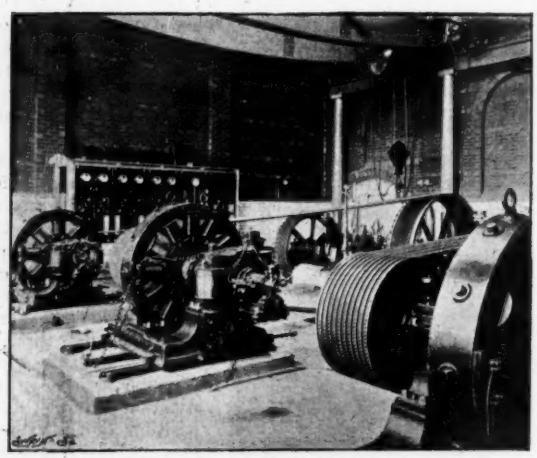
The arrangement of the mains and converting plant is set forth in diagram at fig. 1. Here D is the station end of

a high pressure main, feeding low pressure mains at the converting point or sub-station, E.

Described generally, the low pressure distribution is a network of multiple wire mains—three-wire, usually—laid down in accordance with the ordinary practice and rules of this method of distribution. This network is fed from sub-stations or street boxes, distributed over it at the requisite intervals. At these points converting plant is grouped on the mains thus:—To feed each side of the three-wire network, a comparatively small transformer or group is used, as at B and C. These two must be separate transformers, one with three-wire connections would not do. They, in turn, are supplied from the central station by two primary circuits with a common return; really, by three-wire mains. Also, a large transformer or group, as at A, feeds, and is fed from, the outer conductors of secondary and primary mains direct.

These three comprise what may be called a complete transforming unit of the system, and usually each sub-station would contain a complete unit, though not absolutely necessary.

At the generating station, the plant is arranged to feed the high pressure mains, normally upon the three-wire principle, in any of the well-known manners. And on each primary circuit is a "change-over" switch, by which one of



Southport.—View of Plant before Extensions.

the outer mains can be thrown over on to the same pole as the other; thus converting the system from three-wire into a pair of simple parallel circuits, with the neutral main as common return.

The effect of this conversion is to annul the E.M.F. on the primaries of all transformers connected, as at A; and, further, to produce a relative reversal of the E.M.F. on the primaries of the small transformers connected to that side of the main system, operated on by the switch. A similar reversal is, of course, established thereby on their secondaries. Therefore the secondary mains are also converted from the three-wire to a simple parallel system between neutral and outers, and the E.M.F. on the secondary side of the large transformers is annulled, as on the primary. The latter are thus rendered completely inactive, by the simple change-over made on the primary circuit.

The central station engineer can make the change in either direction, whenever the load on the circuit demands it, and thus he has the converting losses under a very fair degree of control. The transforming plant has two different activities, interchangeable at will, and as already observed, further refinement would be most often superfluous.

Of the questions that arise in the practical application of the system, that concerning the best allocation of converting points over a distributing network is of interest, but too wide to touch on here. However, it is clear that the use of some system of reducing transformer losses will render the converting efficiency of less moment in the greater problem, involving the complete efficiency and economy of distribution. Hence, while conserving the latter, there is more scope to increase the feeding points.

As to the relative sizes of the three elements of the transforming units, the two smaller, as B and C, fig. 1, have, besides taking the light load, to perform the function of balancing the three-wire system. It is necessary then to judge how close a balance can be ensured in practice. Records of the wide and general experience that must now have accrued on this important question are strangely wanting; but Mr. Crompton, being an advocate of feeders of two wires only for three-wire mains, has apparently found it possible to so tap a connected network of them, that scarcely any balancing currents shall be required from the generators. On this basis the balancing duty appears almost a secondary consideration in determining this question, leaving it to be decided from the load diagram what should be the most advantageous proportion between the elements. Whether this affords sufficient margin for possible balancing or unbalanced currents is for consideration in the light of each case.

A good and simple safeguard against overloading either of the small balancing elements, is to put a suitable resistance or impedance in their common junction to the neutral secondary main. Or it is more convenient, and almost as effective,

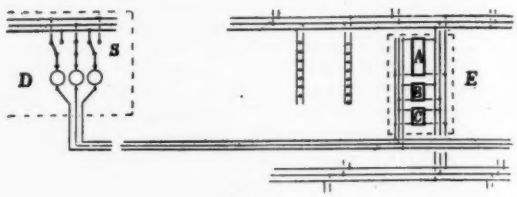


Fig. 1.

to put this on the primary neutral at the station end; here it may be cut out when not necessary, and so removed from vitiating the regulation.

With regard to feeding at more than one point from the same primary mains, there is little or no objection to it, if the secondary network be compact and well connected. Nor is it a necessity, on a similar and nicely balanced network, that a complete transforming unit shall be located in every sub-station. For instance, a convenient arrangement in cases where numerous converting points in street boxes are employed, would be to divide a unit between adjacent points. Either single elements or pairs may be placed at each point. Perhaps the best order is thus: at one point a large transformer connected as A, fig. 1; at the next a pair, as B and C, or better, a compound transformer, as described later, and so on. It is improbable that the balancing currents flowing between these points would ever be large, while the advantage gained by the increased size of elements is considerable.

With reference to the primary mains, the size of the neutral conductor depends upon its light load duty, since its balancing duty must needs be the smaller. At light load, though the working potential is halved, the total copper in

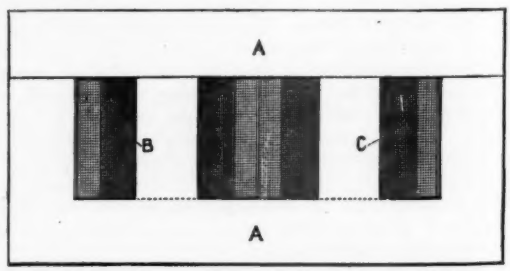


Fig. 2.

the mains is still utilised. Then the size for, say, one-tenth full load, for the same rate of drop as at full load, works out ·22 of the section of either outer conductor. Therefore, one-fourth would be a convenient and adequate proportion for most purposes. A tri-concentric cable with this neutral conductor on the outside, and earthed, if desired, would be a useful form of high pressure main for this system.

I have devised a special duplex transformer for use with my system, which has important advantages. See fig. 2, where A, A, is the carcase built of stampings of the form

shown; B, a pair of primary and secondary coils superposed, encircling one of the two inner limbs of A; and C, a similar pair on the other. Each set is wound for the half-voltage of the system, and when the two are acting in series, the arrangement forms two distinct transformers. But when in parallel, the magnetic circuit of one is completed through the other, and the outer masses of iron are inactive. Therefore, one-half of the iron loss is saved in the latter case, and a very high converting efficiency is secured throughout the long periods of light load. Further, it then divides the load evenly between the two primary circuits, and keeps the

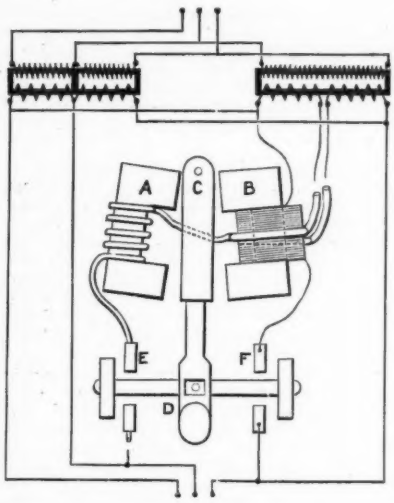


Fig. 3.

E.M.Fs. on the two parallel secondary circuits more equal when unequally loaded.

The system can be easily modified to meet cases in which it is impossible to maintain even a moderate balance on the three-wire mains. By the following method, some or all of the large transformers are made to take up their share of the balancing duty. This provides against even no balance at all; but I much regret it necessitates the introduction of one automatic switch. However, it is a very simple switch; one having only to deal with the low pressure balancing currents; and circumstances admit of its being given an action so powerful as to entirely preclude a chance of failure.

It is shown in diagram, at fig. 3, where A is a laminated magnet wound with a few turns of a stout conductor, which

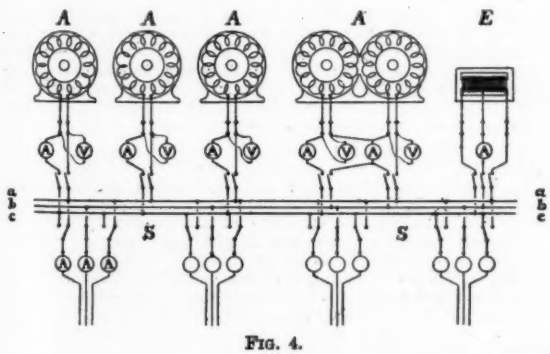


Fig. 4.

connects the central point of the secondary coil of the large transformer with the neutral main, through the switch contacts at E. B is a similar magnet, wound with a coil in shunt across the outer secondary terminals, through the switch contacts, F. Between the two swings the armature, C, part of the weighted pendulum, which strikes over the switch bar, D. The shunt, B, being only in action for a moment, may be as powerful as one pleases; and A, at the moment of action, is a dead short circuit across 100 volts, or so. The action is clear from the diagram. During light load, the connection to the neutral main is broken at E, and the circuit through the shunt, B, is closed, but no current flows in it. When the change-over is made, B becomes subject to some 200 volts, and the armature, C, is violently pulled over, thus closing the neutral main connection and breaking the shunt circuit. The reverse operation is effected by the fact that, when the corresponding change-over is made, the connection through the large transformer short-circuits the mains, the two halves of the transformer coil being magnetically opposed. The rush of current through A, therefore, drags open the switch. To prevent balancing currents from actuating the switch, I put a turn or two of a loop taken from the centre of the secondary round the magnet, B, in the way shown. This holds over the armature so long as the large transformer is active.

There are other ways of operating this switch, but in any case, as it has to deal with but a small fraction of the total current, this modification of my system is still distinctly superior to any of the other methods of switch control.

With respect to the practical arrangement of plant at the generating station for alternating current systems, the method set out at fig. 4 is convenient and efficient, where parallel running is adopted. The alternators, A, A, A, of any size or type, are arranged to feed on to the outer pair of common omnibus bars, *a* and *c*, at the requisite voltage. A^1 is a special duplex alternator, or two of the same type as A, with coupled shafts. Its two sections each give half the voltage of the single machines, and they are coupled in series on to the bars, *a* and *c*, and also from their junction to the neutral bar, *b*. The three-wire feeders proceed from the omnibus bars to the converting points, through the change-over switches, S, S, as already described. In all other details the station plant may accord with usual practice.

The alternator, A^1, takes the light load and the balancing duty. It is simpler, but a trifle less efficient, to replace it by an "equaliser," as shown at E. This is a transformer carcase wound with two equal coils in series, coupled to the three omnibus bars in the same way as A^1. Its size need not be large, of capacity for the day load at most, and where the supply circuits can be balanced against each other, it may be much less.

To that very convenient, but little used arrangement of generating plant, in which low pressure alternators are used, in combination with a bank of step-up transformers, the system is easily adapted by making the latter with three-wire connections on their H.P. side.

(To be continued.)

NEW PATENTS AND ABSTRACTS OF PUBLISHED SPECIFICATIONS.

[*Compiled expressly for this journal by* W. P. Thompson & Co., *Electrical Patent Agents*, 31, *High Holborn, London, W.C., to whom all inquiries should be addressed. Copies of any of the specification may be obtained of* Messrs. W. P. Thompson & Co., *price, post free*, 8½*d.* (*in stamps.*)]

NEW PATENTS.—1895.

19,245. "Improvements in dynamo-electric generators and motors." R. Wood. Dated October 14th.

19,256. "An improved electricity meter for registering the amount of current consumed on direct or alternating polyphase, triphase, or quadruplephase circuits." F. J. Beaumont and F. Hallows. Dated October 14th.

19,260. "Improved electrical apparatus for preventing the collision of railway trains." J E. Florea and A. Olteanu. Dated October 14th.

19,272. "Improvements in or relating to the steering of electric or steam carriages, cycles, bath chairs, or other like vehicles." E. R. Kesterton. Dated October 14th.

19,275. "Improvements in electric incandescent glow lamps." R. J. Bott. Dated October 15th.

19,304. "Improvements in phosphorescent electric lighting." W. L. Wise. (Communicated by the Moore Electrical Company, United States) Dated October 15th.

19,317. "Electric railways." J. La Burt. Dated October 15th.

19,318. "Improvements in combined telephone and signalling systems." J. G. Smith and R. G. Vassar. Dated October 15th.

19,337. "An improved means for connecting the filament in incandescent lamps with the source of current." W. P. Thompson. (Communicated by the Phonix Suddeutsche Glublampenfabrik Gesellschaft mit beschrankter Haftung, Germany) Dated October 15th.

19,340. "Improvements relating to electric cars." P. W. T. Davies. Dated October 15th.

19,353. "Improvements in electric gas-lighting apparatus." J. Jahnsson. Dated October 15th.

19,374. "Improvements in incandescent electric lamps and the method of making the same." S. E. Cox. Dated October 15th.

19,380. "Improvements in the manufacture of insulated cables." G. H Nisbett. Dated October 16th.

19,389. "Improvements in tempering the wire points of textile cards electrically, and in apparatus therefor." C. B. Crawshaw and R. Kennedy. Dated October 16th.

19,402. "Improvements in and connected with return circuits for electric railways and tramways." W. E. Heys. (Communicated by G. Kapp, Germany.) Dated October 16th.

19,442. "An improved method of and apparatus for welding by electricity and for other purposes." A. Hirsch. Dated October 16th.

19,461. "Improvements in thermo-electric generators." H. B. Cox. Dated October 16th.

19,503. "Improvements in telephonic apparatus." C. Adams-Randall. Dated October 17th.

19,519. "Improvements in alternating electric-current transformers." J. A. McMullen. Dated October 17th.

19,527. "Improvements in high insulation fuses or cut-outs for electric lighting." J. M. Urquhart and W. H. Dingle. Dated October 17th.

19,551. "An improvement in conduits for conductors of electricity or other mains." W. D. Reid. Dated October 18th.

19,577. "Improvements in incandescent electric lampholders." P. Lindsay and J. Braden. Dated October 18th.

19,605. "Improvements in and connected with dynamos and the driving of same and electric motors for the driving of vehicles and machinery." J. V. Sherrin. Dated October 18th.

19,628. "Improvements in or relating to electric burglar-alarms and the like." A. J. Boult. (Communicated by R. Damseaux, Belgium.) Dated October 18th.

19,647. "Improvements in secondary batteries." W. H. Willatt. Dated October 19th.

19,669. "Improvements in secondary battery plates." A. Schanschieff. Dated October 19th.

19,670. "Improvements in secondary batteries." A. Schanschieff. Dated October 19th.

19,696. "Improvement in electric light display systems." J. E. Woodbridge. [Date applied for under Patents, &c., Act, 1883, Sec. 103, July 8th, 1895, being date of application in United States.] Dated October 19th.

ABSTRACTS OF PUBLISHED SPECIFICATIONS.

1894.

13,434. "Improvements in the electrolytical production of zinc from its ores, and apparatus therefor." Siemens Bros. & Co., Ltd., 12, Queen Anne's Gate, Westminster. (Siemens & Halske, Berlin.) Dated July 12th. A very strong current of air is maintained in the electrolytic cell so as to cause the deposition of solid zinc instead of zinc sponge. 6 claims.

1895.

5,313. "Improvements in ohmmeters and other electrical measuring instruments." C. W. S. Crawley and A. Soames. Dated March 13th. In ohmmeters of the well-known type having two coils at an angle with each other an astatic needle is used instead of the usual soft iron needle, in order that the instrument may not be affected by the earth's field. 5 claims.

8,255. "Self-generative power machine." G. E. Adams, Howley Lodge, Warwick Road, Maida Hill, London. Dated April 26th. The construction of this machine is based on the following means, principles, or devices:—"Firstly, there is a rotating mass with a given velocity. Secondly, there is lost a quickness of motion to gain great mechanical force through a short distance. Thirdly, the mechanical force is transmuted into another, namely, electricity (by slow motion dynamo). Fourthly, there is a force of electricity applied to magnetise given points. Fifthly, by the rapidity with which the electric current travels potential energy results, or energy of position. Sixthly, particular consideration must be taken of the kinetic energy of the mass. But it is to be borne in mind that these principles must not be argued upon separately, for then action would be equalled by the reaction." The illustrations, when examined with these principles or devices, enables the invention to be clearly understood. 1 claim.

8,385. "An improved wire gauze brush for dynamos and motors." A. B. Soar and E. W. Collier, 8, Phipp Street, London. Dated April 27th. The layers of wire gauze forming the brush are constructed with folds or corrugations in such manner that they cannot separate from each other in use. 5 claims.

8,537. "Improvements in insulating material for electric purposes." A. J. Boult, 323, High Holborn (The Virginia Phosphate and Paint Company, Washington, D.C., U.S.A.). Dated April 30th. The improved insulating material is composed of a titanic material, such as "menaccanite," "rutile," "anatase," and "brookite," about 75 to 85 per cent., "asphaltum" or other suitable hydrocarbon 10 to 20 per cent., and a silicious material, such as rice hulls, about 5 per cent. 2 claims.

11,376. "Improvements in machines for placing fibre on wire." F. S. Randall and J. Shallcross. Dated June 11th. The fibre is applied longitudinally to the wire as it passes through a tapered tube which compresses the fibre round the wire. After leaving the tube the covered wire is whipped or bound with thread to keep the fibre in position. 2 claims.

11,540. "Improved electric primer." The Morris Tube Ammunition and Safety Range Company, Ltd., and A. J. H. Wyatt, 11, Haymarket, London. Dated June 13th. In an electric primer, the combination of two shells, an inner and an outer one, the inner shell, with plug, having a platinum wire attached thereto, and fitted in an insulated manner into an outer shell or tube, having a slit or hole for securing the other end of wire, the end of the outer shell being closed by a wad for retaining the explosive, substantially as described. 1 claim.

12,161. "Improvements in apparatus for automatically indicating fracture of electric conductors." A. J. Moulart, 13, Rue Lambert, Paris. Dated June 22nd. An apparatus for indicating the fracture of electric wires, consisting of two springs, which are kept apart by the tension of the respective wires, and which approach each other at the fracture of a wire, effecting the closing of an electric circuit, whereby a suitable indicating device is operated, substantially as described. 1 claim.

12,229. "Improvements in electric resistances and in the manufacture thereof." H. J. Voight and J. A. Haeffner, Electrical Works, Bockenheim, near Frankfort-on-Main. Dated June 24th. Electrical resistances are made by coating porcelain, talc, glass, or other insulating material with a metal. This may be done by directly conveying the metal on to the insulator, or by applying the metal in the form of a solution and then firing, or by precipitating the metal on the insulator from a solution or by decomposing nickel tetra carbon oxide, or from like metallic carbon oxides. To obtain an even section of the metallic layer this may be strengthened by electrolytic deposits alternately burnt on. 3 claims.

12,468. "Improvements relating to the current supply of electric railways by an auxiliary accumulator battery." A. Muller, 90, Bergstrasse Hagen, Westfalen, Germany. Dated June 27th. In electric railways in which the conditions of working require, at certain places of the railway line or system, a particularly large amount of driving power, the arrangement of a stationary auxiliary battery at the said places, which auxiliary battery is kept charged either by the current-supplying conductors of the installation, or by special separate charging conductors, or else by a special separately-actuated current generator, and which battery, when the respective places of the railway line or system are travelled over by suitable known means of connection, delivers the requisite surplus of current over the amount of current necessary for the remaining part of the railway line or system. 1 claim.

12,649. "Improvements relating to electric railway vehicles." A. Muller, 90, Bergstrasse Hagen, Westfalen, Germany. Dated June 27th. A vehicle carrying an electromotor, and fitted with a sliding contact or any suitable construction, the main feature of the arrangement being that between the terminals of the motor there is inserted an accumulating or storage battery which, by means of well-known switch devices, is charged, whilst in operation, by ordinary current supply or conductors, but which, during its discharge, is capable of keeping the motor in operation. 1 claim.

12,836. "Improvements in automatic electric cut-outs." C. M. Dorman and R. A. Smith, Ordsal Electrical Works, Salford. Dated July 3rd. In automatic electric cut-outs in which dippers of metal or other conductors are withdrawn from mercury containers by causing the dippers to revolve in a circular path round an axis by means of a variation in the strength of an electric current or currents the improved method of arranging the axis round which the dippers revolve in a vertical plane, which intersects or approximately intersects the centre of buoyancy of the immersed parts of the dippers when the switch is in the "on" position for the purpose of preventing variation in the position of the point of unstable equilibrium of the revolving parts of the cut-out through variations in the level of the surface of the mercury. 2 claims.

13,207. "Improvements connected with arc lamps." A. C. Siebold, 36, 15th Avenue, Mount Vernon; E. O. Clark, 537, West 152nd Street, New York City; and W. Sowdon, 65, West 131st Street, New York, U.S.A. Dated July 9th. The invention provides means for prolonging the efficiency of arc carbons by excluding oxygen, and preventing obstruction of light by smutting of the globes. The carbons are enclosed in a transparent shell with tight metal cap with an aperture for the upper carbon sufficiently large to enable same to descend freely. A cap closes the envelope below, with a cone for collecting *débris*, and a sleeve tightly clasping the lower carbon. An internal sleeve of wire gauze arrests the particles of carbon which fall down. 6 claims.

13,348. "Improved methods of distributing power by electricity." F. H. Royce, Eastbourne, Holland Road, Chorlton-cum-Hardy, and E. A. Claremont, Electron, Cavendish Road, Chorlton-cum-Hardy. Dated July 11th. In the three-wire system motors are used wound to the maximum voltage, obtainable from the outside wires of the system and suitably connected to any two of the wires. By this means various speeds of the motors are obtained by these different voltages, without having to insert a resistance in the motor circuit. 1 claim.

13,550. "Improvements in dynamo electric machinery." F. H. Royce, Eastbourne, Holland Road, and E. Claremont, Electron, Cavendish Road, both of Chorlton-cum-Hardy. Dated July 15th. Relates to an improvement in arranging the magnetic circuit and other parts to enclose the armature, so protecting it from external injury, dust, damp, &c. 1 claim.